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THE NEURONE THEORY IN THE LIGHT OF RECENT DISCOVERIES.[1]

G. H. PARKER.

THE nervous system differs from all other systems of organs in that its cellular elements show the highest degree of differentiation. Thus, in the digestive system, the destruction of a few liver cells means only a minute diminution in the amount of bile secreted, a loss that can be entirely replaced through the slightly increased activity of the remaining cells; and in the muscular system the removal of a few muscle fibres from a given muscle may be made good physiologically by a minimal increment of work from the remaining fibres; but the loss of a few or even of a single sensory cell in the retina will produce a blind spot in that organ which no amount of activity from the adjoining cells, aside from possible regeneration, can ever replace. Each sensory cell in the more efficient parts of the retina has a function dependent upon its position and, therefore, different from that of any neighboring cell; and, while this may not be absolutely true of all parts of the nervous sys-

[1] A lecture delivered before the Section of Biology of the New York Academy of Sciences, Jan. 29, 1900.

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tem, it is vastly more characteristic of nervous structures than of any other organs in the body. While in most systems differentiation may be said to have reached the gross organs, in the nervous system it has extended beyond this to the cellular elements. It follows, therefore, that to know the nervous system anatomically a study of its gross organs is not sufficient; we must know its cellular composition. Hence it is that our more fundamental knowledge of the structure of nervous organs is a product of the present century, the century of cellular research.

Although the enunciation of the cell doctrine by Schwann in 1839 was accompanied with a remarkably full description of the cellular components of most animal tissues, including the nervous, it was not until over half a century later that a consistent cellular analysis of nervous organs was accomplished. This was set forth in the conception of the neurone as advanced by the Berlin histologist and anatomist Waldeyer in 1891. The theory of the neurone can best be approached by reviewing briefly the historical steps that lead up to it.

While it is possible that some of the earlier microscopists, and particularly the Scotch anatomist Monro, were acquainted with nerve fibres, the first unquestionable description of these structures was given by Fontana (**1781**), and Stieda, who has reviewed this subject with much care, justly designates this Italian physician as the discoverer of nerve fibres. Fontana's discovery, which for some time failed of the recognition that it deserved, was eventually confirmed by Treviranus (**1816**) and particularly by Ehrenberg (**1833**), whose studies showed that the central nervous organs, as well as the peripheral nerves, were composed of definite fibres. Fontana's work may be regarded as the first step in the modern portrayal of the finer anatomy of nervous organs in that it is the earliest unquestionable description of nerve fibres.

Ehrenberg in the narration of his discoveries not only described and figured nerve fibres, but he also gave an account of other microscopic bodies found in nervous organs, such as crystals, blood corpuscles, and certain roundish bodies which he called "Kugeln" and which subsequent investigators termed

ganglion cells. In 1836 Valentine described these ganglion cells with much care, and two years later Remak claimed that in the sympathetic nervous organs of vertebrates ganglion cells were directly connected with nerve fibres. This proposition was supported and broadened by Helmholtz in 1842, who maintained that what Remak had claimed for the vertebrates was also true for invertebrates. Seven years later, in 1849, Kölliker in the first volume of his newly established *Zeitschrift für wissenschaftliche Zoologie* pointed out the inconclusiveness of the observations of Remak and of Helmholtz. The fibres that these authors had described as arising from ganglion cells were marked in no way as indubitable nerve fibres. Doubtless they were nerve fibres, but the histological knowledge of that day, as Kölliker rightly maintained, did not preclude them from being fibres of another kind. Kölliker then proceeded to show that, in the central nervous organs of vertebrates, ganglion cells could be found that were directly connected with fibres possessing medullary sheaths. As medullary sheaths are found only on nerve fibres, it follows that Kölliker's demonstration was the first in which it was shown beyond doubt that nerve fibres are directly connected with ganglion cells. The connection thus demonstrated made it clear that from this time on ganglion cells as well as nerve fibres must be reckoned as essential parts of nervous organs. This may be said to be the second step in the development of our ideas on nervous tectonics.

The third step in this direction was taken by the histologist Leydig, who, in describing the finer anatomy of the arthropods in 1855, stated that the central nervous organs of the spider contained, in addition to ganglion cells and nerve fibres, masses of material composed of many very fine interlacing fibrils. The minutely granular appearance of this material led Leydig to call it "Punktsubstanz," though he did not commit himself to the idea that it was granular rather than finely fibrous. In 1872 Gerlach, by the use of gold chloride, discovered an essentially similar material in the central nervous organs of vertebrates, and, while he assumed for this material a network structure rather than a simple interlacing of fibrils, the facts that he had at hand were in reality much the same as Leydig

had previously presented. In both vertebrates and invertebrates it was early recognized that this finely fibrous material was directly continuous with the living substance of both nerve fibres and ganglion cells, and therefore formed an integral part of the nervous organs. To this substance, whether it be from vertebrates or invertebrates, His gave the convenient name of "neuropile."

As no other material aside from the three thus far considered has been found to be necessarily connected with nervous organs, we may regard such organs as made up of a combination of nerve fibres, ganglion, or, as they are often called, nerve cells, and neuropile. The mutual relations of these three materials must next be considered.

The problem of the relation of these nervous materials has been discussed chiefly from the standpoint of the anatomical origin of nerve fibres. When a nerve fibre is traced into a central nervous organ, from what is it found to take its origin? Does it pass out from a ganglion cell, does it originate from the neuropile, or does it come from some other source? This is what is meant by the anatomical origin of nerve fibres, and, on this question the earlier neurologists were divided into three schools. First, there were investigators, like Buchholz, who attempted to maintain that all nerve fibres arose directly from ganglion cells. Next, there were those who, with Leydig at their head, believed that nerve fibres were formed by a drawing together of many fibrils in the neuropile, whereby the transmitting core of a fibre was established. The advocates of this view also believed that the fibrils of the neuropile were derived from the finely divided processes of ganglion cells, and that, therefore, nerve fibres were connected with ganglion cells through the neuropile. Hence they rightly designated their view as that of the indirect origin of nerve fibres as contrasted with the origin of these structures directly from ganglion cells. Finally, there were those who, like Gerlach, maintained that both methods of origin occurred, *i.e.*, that some fibres arose directly from cells and others indirectly through the neuropile. In support of this opinion Gerlach instanced the condition of the spinal nerves in vertebrates (Fig. 1), in which the dorsal

fibres spring from the neuropile, *i.e.*, have an indirect origin, and the ventral fibres arise directly from ganglion cells in the ventral horn of the cord. This example was practically conclusive, and later neurologists have been generally free to admit that nerve fibres differ as to their mode of origin, some coming directly from cells, others indirectly, *i.e.*, from the neuropile.

All-absorbing as many of the neurologists of the past found this problem of the anatomical origin of nerve fibres, its solution was followed by no important generalizations. This is probably due to the fact that the views of both the principal

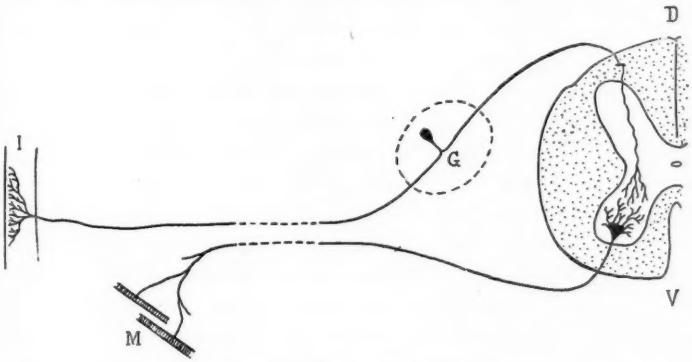

FIG. 1. — Ideal transverse section of vertebrate spinal cord illustrating the extent of a dorsal and of a ventral neurone. The dorsal neurone begins in the integument (*I*), has its cell body situated in the dorsal ganglion (*G*), and enters the cord at the dorsal side (*D*). The ventral neurone has its cell body in the ventral part of the cord (*V*) and is distributed peripherally to muscle fibres (*M*).

contending parties proved to be correct, and the whole conflict, like the inconclusive battles of military history, was lost sight of. But the mass of observations accumulated in the discussion of the anatomical origin of nerve fibres was destined to become a soil from which new growth was to spring. The change that now came over this field of inquiry was in part due to the invention of two new methods of research, Golgi's silver impregnation method and Ehrlich's methylen-blue staining, and in part to a new way of looking at old problems, which, though vastly stimulated by the results obtained through the new methods, was in a measure independent of these. It is note-

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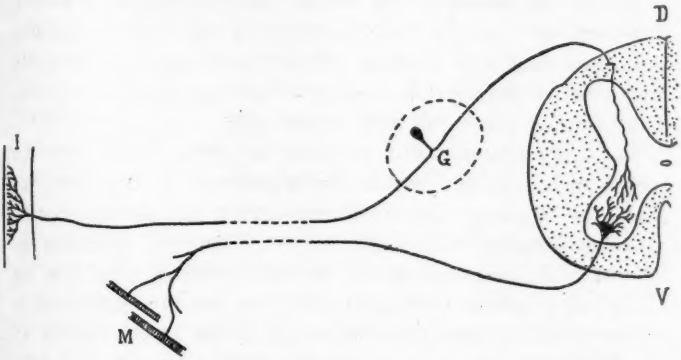

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worthy that this new departure was initiated to a large extent by one of the oldest working neurologists, Kölliker, who, in his presidential address, delivered before the Anatomische Gesellschaft at Munich, in May, 1891, pointed out the relative unimportance of the problem of the anatomical origin of nerve fibres and raised the really vital question, Is there any nerve fibre not directly connected in some part of its course with a ganglion cell? To this question Kölliker gave a negative reply, and this reply has been confirmed by all subsequent investigators. Every nerve fibre, be it of direct or of indirect origin, is somewhere in its course directly connected with a ganglion cell. In the vast majority of cases the fibres are associated each with a single cell and no more; but in some instances, as, for example, among the worms, fibres are known to be directly connected with several cells.

Kölliker's generalization contains the germ of the neurone theory and leads at once to the statement of that theory as made by Waldeyer in an address before the Berliner medicinische Gesellschaft in June, 1891. This may be stated as follows: The nervous system is not correctly described as composed of nerve fibres, ganglion cells, and neuropile, but it is composed of nervous cells whose bodies we recognize as ganglion cells and whose processes are the cores of the nerve fibres and the neuropile directly connected with these cells. The nervous system then is made up of units, each one of which consists of a ganglion cell provided with longer or shorter processes, the cores of the nerve fibres, and producing from its surface and from that of its fibres fine fibrils, which collectively constitute its neuropile and which bring it into physiological connection with other such units. To these nervous units Waldeyer gave the name "neurones," and the belief that neurones are the structural elements of the nervous system constitutes the neurone theory.

It must be plain from what has been said that each neurone is nothing more than a modified cell. It is characterized, as a rule, by the possession of only one nucleus, and its most obvious peculiarity is that its cytoplasm is in part drawn out into very delicate and enormously elongated processes, the cores of

the nerve fibres. If the neurone is only a cell, it should then show the general properties of a cell, and it is from this standpoint that the neurone theory has been most satisfactorily tested. In this connection it is necessary to examine briefly the development of nerves, the degeneration and regeneration of nerves, and the nature of the neuropile.

The development of a nerve was early sketched by Remak (**1836**) and by Schwann (**1839**); both maintained that each fibre consisted of a series of cells fused end to end. This view was accepted by many later investigators, notably by the English embryologist Balfour, who showed that in the elasmobranch fishes the nerve fibres were early represented by lines of cells. This hypothesis of the chain structure of nerve fibres was not, however, without its opponents. Von Kupffer seems to have been the first to catch the idea that at least the core or axis cylinder of a nerve fibre was an outgrowth from the ganglion cell. This view was subsequently supported by others, especially by His, whose brilliant investigations on the development of the nerves show beyond a doubt that the axis cylinder is an outgrowth from a ganglion cell (Fig. 2). The forming axis cylinders may become surrounded by cells that eventually develop into the sheath cells of the fibre, and these undoubtedly formed the lines of cells mistaken by many investigators for developing nerve fibres. The resolution of a nerve fibre into a chain of cells, as implied in Remak's original description, is entirely at variance with the neurone theory, but the establishment of the idea that the essential part of every nerve fibre, the axis cylinder, is an outgrowth of a ganglion cell is in perfect accord with it. In the development of its parts, the neurone acts as a single cell; its processes, the axis cylinders of the nerve fibres, are its outgrowths.

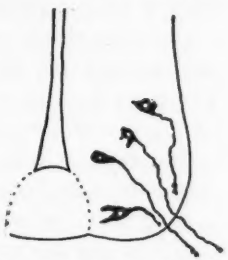

FIG. 2. — Transverse section of the ventro-lateral wall of the developing spinal cord of a chick (in part after Ramon y Cajal). Four cells are shown in process of forming the axis cylinders of future nerve fibres. The outgrowths from the two middle cells have extended beyond the limits of the cord; those of the two other cells still lie within that structure.

The degeneration and regeneration of nerves also afford an

opportunity of testing the theory. It has long been known that when a nerve is cut or a bundle of fibres in a central organ injured, some fibres degenerate in one direction, some in another. The question naturally arises, do these degenerations take place in accordance with the assumed cellular nature of the neurone?

Experiments upon large protozoans have shown that when these unicellular animals are cut in two so that one part, which may be the smaller, contains all the nucleus and the other is without even a fragment of this organ, the part without the nucleus invariably soon dies, while that which retained the nucleus may regenerate the lost part and continue to live. The nucleus is in some way absolutely essential to the continued life of the cell.

The same is true of nerve fibres. If a nerve be cut, that portion of each fibre which is thus severed from the nucleus-bearing part, the so-called ganglion cell, invariably dies, even though it remains among the tissues of the body and is bathed in the fluids that are presumed to nourish it. This rule holds for all the degenerations of the nervous organs; after severance the non-nucleated portions of the neurones degenerate precisely as the non-nucleated portion of the protozoan body degenerates. The degeneration of nerve fibres then takes place in accordance with the conception of the neurone as a single cell.

Precisely as the nucleated portion of the divided protozoan body continues to live and may regenerate its lost parts, so the nucleated portion of the neurone remains alive, and, if the injury has not been too severe, may reëstablish itself by throwing out new axis cylinders from the cut end of the old one, and thus new fibres may by growth reëstablish many of the former connections. Regeneration in the neurone, as in the protozoan cell, takes place from the nucleated part; and this phenomenon, as well as that of degeneration, points very clearly to the conclusion that the nucleus of the neurone, like that of any other cell, is a center on which the life of even the most remote portion of the cell is dependent.

This conclusion leads us directly to an important interpre-

tation of the neuropile. If the nucleus of each neurone is a center from which the life of the whole neurone is controlled, then this control must extend, in the case of a given neurone, over that portion of the neuropile associated with it; in other words, the neuropile cannot be considered a diffuse network, as claimed by Gerlach, but must be regarded as divided into provinces, each one of which is under the rule of the neurone with which that particular part is associated (see Fig. 1). The boundaries between these provinces must, then, mark the real limits of the neurones, and that such boundaries actually exist, at least in a physiological sense, is to be inferred from two classes of observations. First, in the degeneration of the central fibres of one of two intimately associated sets of neurones, the degeneration proceeds into the neuropile but not across it, showing that the separation of the neurones lies somewhere in that material. Secondly, since the embryonic cells from which neurones finally develop are in the beginning often widely separated from each other, it follows that their association must be brought about by their gradual growing towards each other, and, as their first step in union would be that of the simple contact of their neuropile masses, it is possible that this relation is all that ever exists and that the points of separation in the neuropile are the original contact points of the developing neurones. For this ingenious suggestion we are indebted to the Swiss neurologist Forel, who, with a keen appreciation of the significance of the embryological investigations made by His, has given us what has been called the Contact Theory of the relation of neurones. This theory, which, when coupled with du Bois-Reymond's hypothesis of a neuropile capable of movement, has been eagerly followed up by many psychologists, is generally supposed to be an essential part of the neurone theory itself; but, though it was undoubtedly so regarded by its earlier advocates, it must be borne in mind that it is in reality not a necessary part of this idea, which has to do with the conception of the neurone unit as a cell rather than with the mutual relations of such units.

The discussion has now led us to a position where a fairly full statement of the grounds for the neurone theory may be

made. First, embryology has shown that the nervous system in the beginning is a mass of essentially independent cells, some of which by throwing out processes to form nerve fibres and by other modifications become converted into specially differentiated nervous cells, or neurones. Secondly, the cellular character of each neurone is asserted in later life in that all parts of the neurone remain dependent upon their connection with the nucleus for continued existence and are independent of adjoining neurones. This is seen in the peculiarities of the degeneration and regeneration of nerve, operations that are paralleled in experiments on protozoan cells.

Notwithstanding the obviousness of the cellular nature of the neurone, it must not be forgotten that these cells are of a very exceptional character. Imagine a cell whose nucleated body, scarcely visible to the naked eye, is lodged in the spinal cord of some such animal as an elephant, and whose process, in the form of an axis cylinder as fine as gossamer, stretches from this place through meters of flesh to the animal's foot, and yet the relation of the most distant part of this process to the cell body is so subtile that, should the connection be anywhere severed, the degeneration of the disconnected part invariably follows. It is not strange that such cells as these were not clearly understood by the earlier histologists, for even now they may well excite our wonder.

The objections to the neurone theory are naturally of very recent origin. One of the first to be raised was that of the direct union of cell bodies through their coarser processes. This was found by Dogiel to occur in the ganglionic layers of the retina (Fig. 3), and similar conditions were recorded by other investigators in various nervous organs; but these instances have always proved exceptional, and, while it must be admitted that nervous cells are sometimes united directly, such

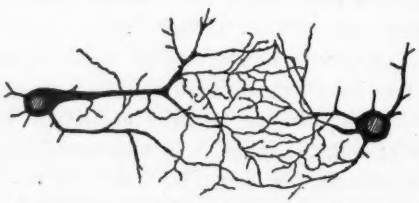

FIG. 3. — Two ganglion cells from the vertebrate retina showing protoplasmic anastomoses (slightly modified from Dogiel).

cases seem to be relatively rare. So far as their bearing on the neurone theory is concerned, I agree with Barker that they form no greater objection to the general theory than the occurrence of Siamese twins does to the general idea that the human species is represented by separate individuals. This form of objection has certainly shown itself to be trivial.

A much more serious obstacle comes from the work associated with the name of Apáthy. This investigator has developed methods which in point of perfection exceed the Golgi

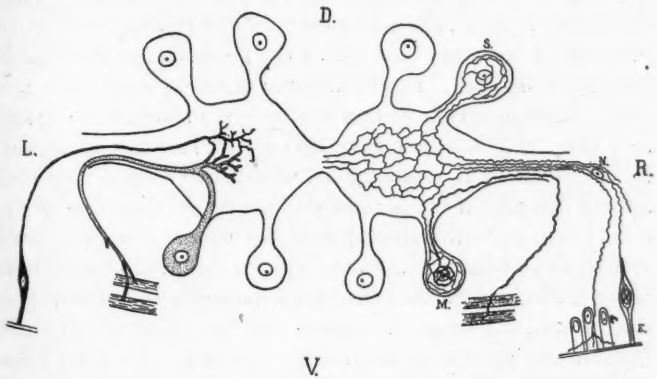

FIG. 4.— Posterior view of a transverse section of the ventral nerve chain of a leech (modified from Apáthy). The median plane of the leech is represented by *D* (dorsal), *V* (ventral). On the left side (*L*), the nervous elements are represented according to the neurone theory, a sensory neurone being represented in solid black, and a motor one dotted. On the right side (*R*) the nervous elements are represented according to Apáthy. The neurofibrils begin in or between the integumentary epithelial cells (*E*), from which they pass centrally into sensory ganglion cells (*S*) or motor ganglion cells (*M*). From the latter, coarse neurofibrils pass peripherally to muscles. The neurofibrils are produced by nerve cells, a nucleus of one of which is shown at *N*.

and the methylen-blue methods as much as these surpassed the ones before them. Apáthy's methods do not outline neurones; they differentiate the transmitting substance within the neurone. Instead of a coarse nerve fibre or ganglion cell colored homogeneously, one finds a clearly differentiated system of delicate fibrils that constitute collectively the transmitting apparatus of the nervous organs. The peculiarities of Apáthy's methods can be easily appreciated by inspecting the accompanying diagram (Fig. 4), taken from the nervous system

of the leech and outlined on the left side in accordance with the older methods and on the right after Apáthy. It will be seen at once that Apáthy's methods have to do with the interior of neurones, whereas the older methods dealt with their outlines only. When the fibrillæ so clearly demonstrated by Apáthy are traced, they are found to begin in some cases possibly between the external epithelial cells of the skin, in most cases certainly within these cells, around whose nuclei they form a network, after which they extend as bundles of fine fibrils (sensory nerve fibres) to the central nervous organs. Here they separate, and either enter into the formation of a true network (in what has been called the neuropile) or pass at once into a ganglion cell, in the substance of which they form a network. Ganglion cells of this structure are supposed to be sensory (Fig. 4, *S*). Motor ganglion cells (*M*) are also penetrated by the fibrils from sense organs, which then form a branching system just within the periphery of the cell. From this peripheral system (external plexus) branches extend inward to unite around the nucleus in a second system (internal plexus), from which a single large fibril emerges to make its way eventually as the transmitting organ of a motor fibre to a muscle into whose fibres it may enter after branching. These fibrils are the transmitting organs of the nervous system and are called by Apáthy "neuro-fibrils"; and what is most characteristic about them is that, from their beginnings in or about the sensory cells to their endings in the muscles, they are absolutely continuous; they branch and recombine, but they never show lack of continuity; and this continuity of the fibrillar substance is the feature that characterizes what has been called the fibrillar theory — the supposed opponent of the neurone theory.

Apáthy's opposition to the neurone theory does not stop here, for he has a conception of the structure of the nervous system quite at variance with the tenets of this theory. He holds that the cells connected with nervous operations are of two kinds, which he calls nerve cells and ganglion cells. Nerve cells are those cells that produce fibrillar substance, and this substance in its growth enters sensory cells, ganglion cells, muscle cells, etc.; in short, it is the means of binding the whole nervous

system together. Ganglion cells are those cells that produce what is transmitted by the fibrillar substance, namely, nervous impulses.

So far as I am aware, Apáthy has never placed upon record the observations that justify these distinctions, and, as criticism and acceptance of his unsupported statements are equally premature, it seems to me that, till facts are presented, this side of his work must be passed over. If this is done, the character of the fibrillar substance is the only feature of Apáthy's work that requires present consideration. The distribution of this substance is for the most part within neurones. Hence Apáthy's discoveries have to do mostly with the internal anatomy of the neurone, and from this standpoint they afford no ground for attacking the neurone theory. In one respect, however, they bear in an important way on this theory, namely, in the structure they indicate for the neuropile. Is the neuropile a continuous network made up of the anastomoses of neurofibrils, as claimed by Apáthy, or does it lack this continuity in that it is composed of systems of branches derived each from a separate neurone and related only through contact, as implied by the neurone theory?

Apáthy's figures and statements favor in an unqualified way the idea of continuity, but the solution of this problem, one of the most difficult in modern histology, is to be accomplished only by the aid of many hands. It is, therefore, gratifying to find that Bethe has devoted no small amount of time to a critical study of Apáthy's methods and results. Bethe has confirmed many important statements made by Apáthy, but he has been unable to find reasons for accepting Apáthy's distinction of ganglion and nerve cells, and he has shown that Apáthy's generalization of motor fibres, being characterized by one coarse fibril, and sensory fibres by many small ones, does not hold true for the arthropods. He has, however, confirmed the principal statements of Apáthy as to the presence of neurofibrils in nerve fibres and in cells; and, on the important question of the nature of the neuropile, Bethe agrees in his conclusions with Apáthy in stating that it is a continuous network. When, however, the facts for this conclusion are sought for in the

body of Bethe's paper, they are found to be not very convincing. In his third study[1] on the central nervous system of the crab (Carcinus), he discusses the question of fibrillar continuity in the neuropile and states that in this animal he has never been able to discover continuity between the fibrils of two neurones, though he has some evidence from the leech that he believes supports this idea and that he proposes to publish later. Such a statement of lack of conclusive evidence on an all-important point can scarcely be called a confirmation of the idea of continuity.

These seem to me the most important contributions made against the neurone theory, and I believe it must be admitted they are not fatal objections. In no case has any one made observations which show that each neurone does not begin as an essentially independent cell, suffering eventually remarkable modifications, but still retaining its character as a single cell. In no case has any one shown that the individuality of the adult neurone, as seen in the degeneration and regeneration of its parts, has suffered any reduction as compared with that of the simple cell from which it came. It seems to me, therefore, that the neurone theory is still intact, and that what has been shown by this new work is that the interior of a neurone has a most delicate and complicated fibrillar structure, which possibly is a means of welding together adult neurones much more closely than has been generally admitted. But of this we have as yet no adequate proof.

[1] Bethe, Albrecht. Das Centralnervensystem von Carcinus Maenas. Ein anatomisch-physiologisch Versuch. II. Theil. (3. Mittheilung). *Archiv für mikroscop. Anat.* Bd. li, pp. 382–452, Taf. XVI–XVII. 1898.

VARIATION IN THE VENATION OF TRIMEROTROPIS.

JEROME McNEIL.

A RECENT study of nearly all the known species (fifty out of fifty-four) of the orthopteran genus Trimerotropis has afforded the writer an opportunity to note the amount of variation which occurs in the venation of the tegmina and wings of a single genus. Three out of the four subfamilies of Acrididæ found in North America north of Mexico, *i.e.*, Acridinæ, Tryxalinæ, and Œdipodinæ, present but a single and little modified type of venation well represented by the *Tr. vinculata* Scud (Figs. 1, 2).

The remaining subfamily, Tettiginæ, is so extremely different as to show little relationship to Acrididæ. In all the drawings the terminology used is that of Comstock and Needham, with the very slight modifications necessary to adapt it to Orthoptera. The homologies have been determined by the writer from a study of the tracheation of the tegmina and wings of nymphs, which is to be published shortly.

It will be noticed by those familiar with this nomenclature that the branches of *R.* have been named as if they were accessory branches entirely, whereas it is very probable that some of them represent the primary forks of that vein. At present it is impossible to be quite certain of these homologies, so that the simplest way of naming them has been employed without claiming for it complete accuracy.

VARIATIONS WITHIN A SPECIES.

For the purpose of studying the variation within the limits of a single species I have selected *Tr. saxatilis* McN., a species from Arkansas and southern Illinois, and one of the three species known to occur east of the Mississippi. This form was not selected because of its being unusually variable in venation,

but because I had a larger number of specimens (fifty-seven) of this than of any other species, and these were all collected during the same season in four or five counties of northwest Arkansas, except three, which came from Union County, Illinois. At the same time it is well to note that it is more variable in color than any other species known to me. It frequents stony surfaces exclusively, and its colors vary with the colors of the stones. On black rocks it is nearly black in color, while on

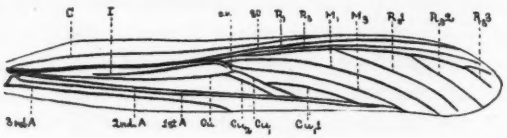

FIG. 1.

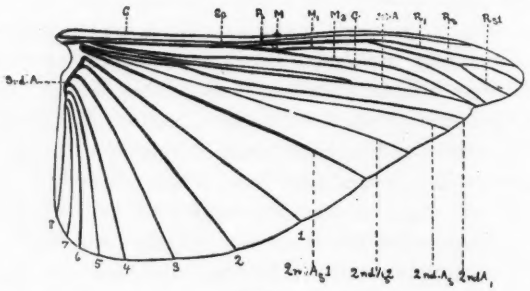

FIG. 2.

C., costa; *Sc.*, subcosta; *R.*, radius; *R.*1, first fork of radius; *R.*3, radial sector; *R.*3 1, 2, etc., 1st, 2d, etc., branches of *R.*3; *M.*, media; *M.*1, first and second forks of *M.* fused; *M.*3, third and fourth forks of *M.* fused; *I.*, intercalary; *c.v.*, cross-vein at end of area *M.*; *Cu.*, cubitus; *Cu.*1, first fork of cubitus; *Cu.*2, second fork of cubitus; *Cu.*1 1, 2, first and second forks of *C.*1; *Cu.*2, 1, first fork of *C.*2; *1st A.*, first anal vein; *2nd A.*, second anal vein; *2nd A.*1, first fork of *2nd A.*; *2nd A.*3, sector of *2nd A.*; *2nd A.*3 1, 2, first and second forks of the sector of the second anal vein; *3rd A.*, third anal vein; *3rd A.*, 1–8, accessory branches of *3rd A.*

The tegmina and wings are divided by the principal veins and their branches into areas which take the name of the vein or branch immediately anterior.

hillsides covered with black and white lichen-covered fragments of chert it is colored black, white, and green, so that away from its environment it is a very conspicuously colored insect. It will require, however, more extended observations than I have been able to make to know whether or not there is any relation between variation in coloration and venation.

In the tegmina *C.* and *Sc.* are simple veins which do not vary in such a manner as to be readily noted; the former is about halfway between the anterior margin and the three succeeding veins, which are so closely approximate on the proximal half of the tegmina as to appear one vein to the unaided eye. *R.* is quite variable, though $R._1$ does not share in this variation. $R._s$ has normally three branches in the male and four in the female, but of the fifty-seven specimens examined six males have four branches and one male has two, and eight

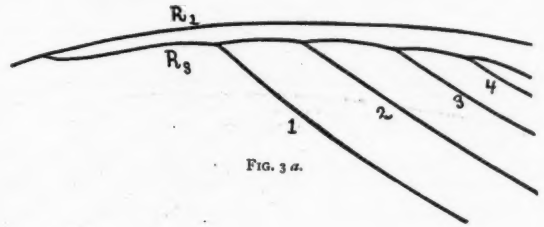

FIG. 3 *a*.

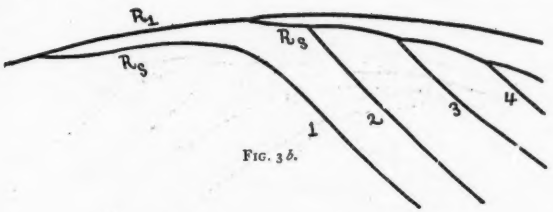

FIG. 3 *b*.

females have three branches; thus about 24 per cent show irregularity in this respect. Within the genus the variation which normally occurs in the number of branches of *R.* is exactly the same; within the subfamily the range is considerably greater, being but one in Celes and six in Pachytylus, both old-world genera. In a single instance the apical part of $R._s$ with two branches has lost its connection with the basal part with one branch, and the former is separately connected to $R._1$ (Figs. 3 *a*, 3 *b*).

No similar variation is normal in the genus nor within the subfamily, so far as I know. The second branch of $R._s$ may

lose its connection with $R._3$ and become attached to the first branch (Figs. 4 *a*, 4 *b*).

This arrangement is abnormal in the genus and probably in the subfamily, and occurs but once in the fifty-seven speci-

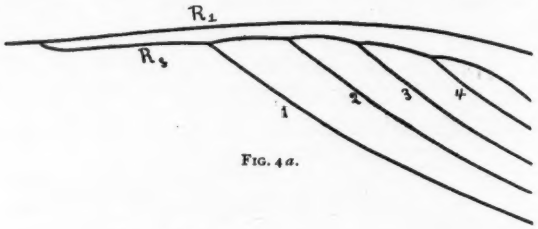

FIG. 4 *a*.

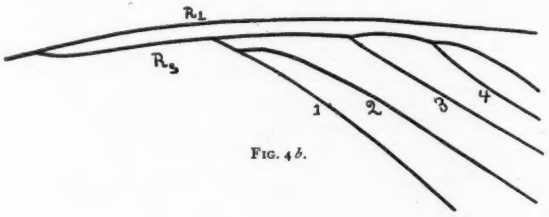

FIG. 4 *b*.

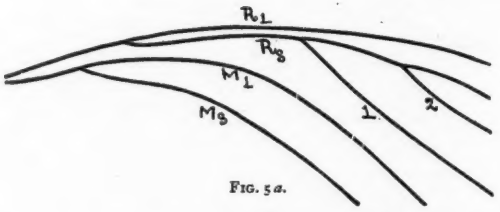

FIG. 5 *a*.

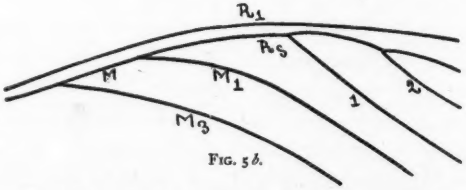

FIG. 5 *b*.

mens; but in this case the irregularity is present in both tegmina. In a single instance, also, the third branch in one tegmen forks. Finally, in three specimens, two males and one female, $R._3$ leaves $R._1$ and becomes attached to $M._1$ (Figs. 5 *a*, 5 *b*).

This occurrence is common in *Psinidia eucciata*, if it is not the rule, and it seems to be natural to Œdaleus. The fork of *R.* is quite variable in position. Generally it is one-third the width of the tegmina at this point distad of *M.* fork, but in three cases it is more than one-half, while in one instance it is more than once, and in another one-eighth, the width of the

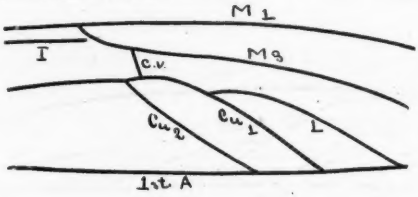

FIG. 6 *a*.

tegmina distad of the same point. This is certainly equal to any similar variation normal to the genus and is rarely exceeded in genera of the subfamily. *M.* has two simple forks, $M._1$ and $M._3$, which do not vary conspicuously. The fork of *M.*, however, which is usually decidedly proximad of the fork of *Cu.*, in four females and two males, is parallel with it or even slightly distad. In a single instance the cross-vein, which is always

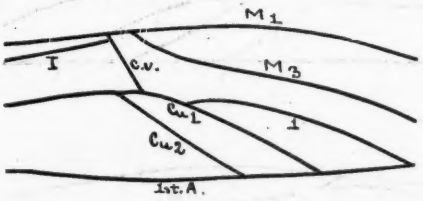

FIG. 6 *b*.

present at the outer end of area *M.*, and which usually, in the genus as well as in the subfamily, when present, connects $M._3$ and $Cu._1$, joins the main stem of *M.* with $Cu._1$ (Figs. 6 *a*, 6 *b*).

The intercalary vein, which is usually separated apically from *M.* by once, male, or two or more times, female, its width, has this relation reversed in a single female and seven males.

In one specimen $M._3$ loses its connection with $M._1$ and appears to be a continuation of *I.* (Figs. 7 *a*, 7 *b*).

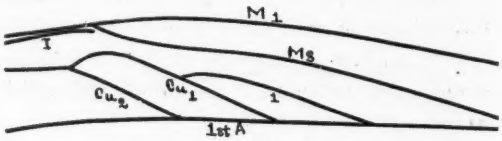

FIG. 7 *a*.

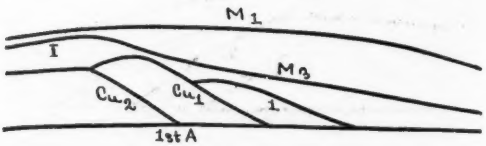

FIG. 7 *b*.

Cu. is quite variable, typically; $Cu._1$ has a single anterior branch which leaves the stem near the base, but in one specimen this branch is joined to $Cu._1$ below its middle, and in one case there are two branches on one side. In the genus there

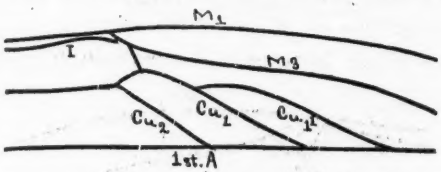

FIG. 8 *a*.

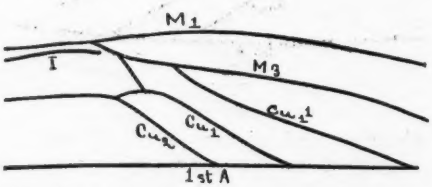

FIG. 8 *b*.

are never fewer than one, nor more than two, branches normally. In one female in one tegmen the branch of $Cu._1$ is transferred to $M._3$ (Figs. 8 *a*, 8 *b*).

1st A. and *2nd A.* are simple veins, whose variations are not easily noted; but *3rd A.*, while usually simple and free to the posterior margin or with its apex lost among the numerous cross-veins of the anal area, is definitely connected apically with *2nd A.* in four males and two females. In all cases except one this fusion is common to the two tegmina. This is the rule in Chortophaga.

In the Wing.

As in the tegmina, *C.* and *Sc.* are simple and vary little; the former occupies the costal margin; the latter is approximate to, or fused with, *C.* on the distal one-half or one-third of the wing; $R._1$ remains simple. $R._s$ varies greatly, while it generally has one branch; in five males and one female it has none,

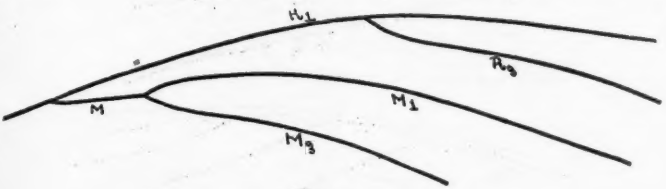

FIG. 9 *a*.

and this is the usual condition in Encoptotaphus, Chortophaga, and Derotmema. This branch of $R._s$ varies from less than one-fourth the length of $R._s$ in two males and one female to more than one-half in five males and four females; when normally developed it is about one-third. *R.* fork should be halfway

FIG. 9 *b*.

from the union of *M.* and *R.* to the tip of the wing. In numerous specimens it is a little more, and in two males and two females less, than one-third of the way. In two males $R._s$ has no branch and is connected with $M._1$ instead of $R._1$ (Figs. 9 *a*, 9 *b*).

The union of $R._s$ with $M._1$ in the wing is characteristic of the genus Dissosteira (except *D. venusta* Stal). *M.* is also quite variable. Its forks are always simple, but in four males they join *R.* separately (Figs. 10 *a*, 10 *b*).

Usually, the stem of *M.* before it branches is rather more than the width of the area *M.*; but in five males and two females it is less than once as wide, in this respect resembling

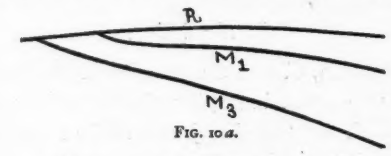

FIG. 10 *a*.

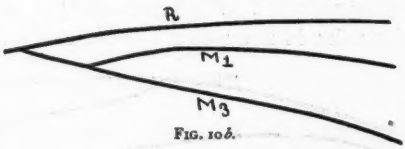

FIG. 10 *b*.

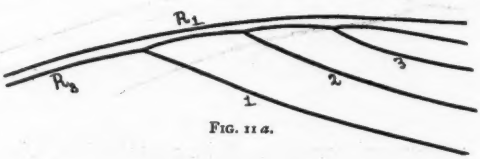

FIG. 11 *a*.

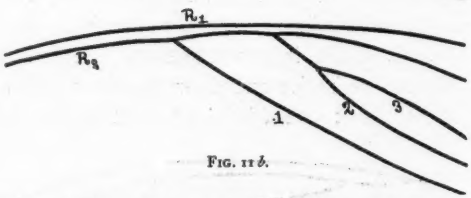

FIG. 11 *b*.

the genus Arphia; and in seven males and five females it is more than twice as wide, which is the usual condition in the genus Hippiscus. *Cu. 1st A.*, *2nd A.*$_1$, and *2nd A.*$_s$ offer no easily noted variations; but the union of *2nd A.*$_s$ *2* with *2nd A.*$_s$ may be, apparently, distant from the base as much as two-fifths, or as little as one-fourth, the length of the latter. When the distance is less than two-fifths, however, a diagonal cross-vein at this point indicates the normal connection of the vein and its branch.

In conclusion it may be said that the variations in the tegmina and wings of one side average nearly two in the females and rather more than two in the males, as variations on one side are generally repeated upon the other; the average num-

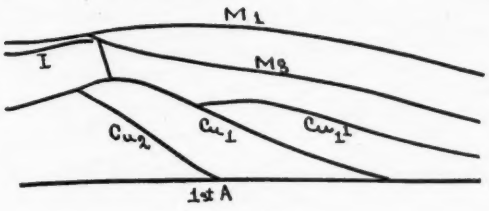

FIG. 12 *a*.

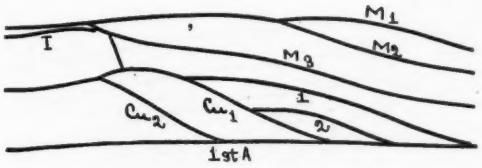

FIG. 12 *b*.

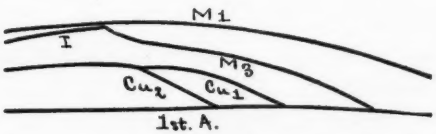

FIG. 13 *a*.

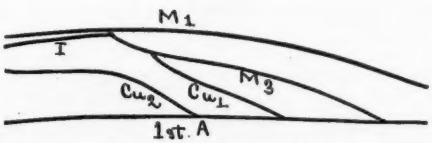

FIG. 13 *b*.

ber on both sides would be not much less than four. There were almost exactly three variations in the tegmina to two in the wings.

VARIATIONS WITHIN THE GENUS.

In addition to the variations which have already been mentioned as occurring in *Tr. soxatilis* the following have been

noticed, one or more times, in other species of the genus. In *Tr. lanta* the second and third branches of $R_{.s}$ have a common stem (Figs. 11 *a*, 11 *b*).

In *Tr. azurescens*, $M._1$ may fork (Figs. 12 *a*, 12 *b*).

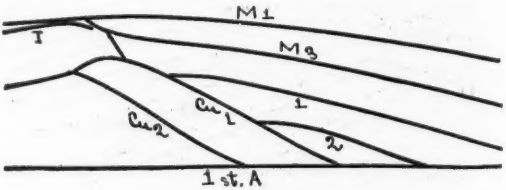

FIG. 14 *a*.

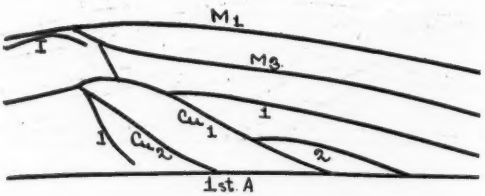

FIG. 14 *b*.

In *Tr. albolineata*, Cu_1. loses its connection with $Cu._2$ and becomes attached to $M._3$ (Figs. 13 *a*, 13 *b*).

Unless the tegmina figured by Saussure[1] is abnormal, this is the usual condition in the genus Scintharista. In the species *Tr. vinculata*, $Cu._2$ may be branched (Figs. 14 *a*, 14 *b*).

GENERAL CONCLUSIONS.

1. Variations in venation which occur within a single species are much greater than those differences which distinguish one genus from another. That is to say that many of the variations which occur are not restricted to what are commonly considered specific limits, but are such as are paralleled only in widely separated genera of the subfamily, and some of them do not normally occur within the limits of the subfamily.

2. Variations in venation which occur in the various species

[1] Saussure, H. de. *Prodromus Œdipodionum*, Pl., Fig. 10. Geneva, 1884.

of the genus merely serve to strengthen the conclusion just formulated, and, except in the number of branches of radius in the tegmina and wings, are greater than normally occur in the subfamily.

3. Variation affects chiefly the veins $R._3$, *M.*, and *Cu.* in the tegmina, and $R._3$ and *M.* in the wings, and these on the outer half of the wings only.

4. Variation in venation is more frequent in the tegmina than in the wings.

5. When the tegmina are widened, new veins are supplied by accessory branches of $R._3$ and $Cu._1$.

NOTES ON THE MAMMALS OF PRINCE EDWARD ISLAND.

ROBERT T. YOUNG.

THE following is an annotated list of mammals observed during a three weeks' stay in Prince Edward Island in the fall of 1897.

1. *Sciurus hudsonicus gymnicus.*—A fairly common species. My specimens agree pretty closely in size with those from New Brunswick and Nova Scotia. It is interesting to note that skins from this section average decidedly smaller than those from Ontario (Miller)[1] and Labrador (Bangs).[2] This seems rather strange, considering that in grading off into the southern form, *loquax*, it increases rather than diminishes in size. Average of six specimens from New Brunswick (American Museum of Natural History, New York): total length, 277; tail, 110; hind foot, 43. Average of ten from Digby, Nova Scotia (Bangs): total length, 296; tail, 113; hind foot, 45. Average of two from Prince Edward Island (Young): total length, 282; tail, 113; hind foot, 45. Average of four from Hamilton Inlet, Labrador (Bangs): total length, 309; tail, 120; hind foot, 48. Average of eight from Ontario (Miller): total length, 309; tail, 121; hind foot, 47. Average of eight *Sciurus h. loquax* from Liberty Hill, Connecticut (Bangs): total length, 318; tail, 134; hind foot, 47.

2. *Mus musculus.*—One specimen was caught in a bushy field, largely grown up with Juncus, near Georgetown.

3. *Peromyscus canadensis.*—Two specimens were all that I secured, both being taken beneath a stump fence bordering some wet woodland, near Kensington. As both are immature I cannot state with certainty the variety, but they appear

[1] Mammals of Ontario, *Proc. Boston Soc. Nat. Hist.*, vol. xxviii, No. 1, pp. 1–44.

[2] A Review of the Squirrels of Eastern North America, *Proc. Biol. Soc. Washington*, vol. x, pp. 145–167.

to be *Peromyscus canadensis*. The scarcity of this species seems remarkable.

4. *Evotomys gapperi*. — A small series was secured, mostly along the borders of woods.

5. *Microtus* ————. — The meadow mouse of Prince Edward Island is apparently an intermediate form between *M. pennsylvanicus* and *M. terrænovæ*. It has the slightly more flaring zygoma and slightly greater interorbital constriction of the latter species. Regarding the enamel pattern of *m 3*, which Bangs[1] considers a characteristic feature of *M. terrænovæ*, I have not been able to distinguish any constant difference between that species and *M. pennsylvanicus*, although I have examined carefully the skulls of both species. The nose patches in my specimens, while more pronounced than in *M. pennsylvanicus* from New Brunswick and other points, are less so than in *M. terrænovæ;* and the color of the back is about intermediate between that of the latter species and of *M. pennsylvanicus* from New Brunswick, some skins having the brownish gray color of New Brunswick specimens, and others the reddish cast of *terrænovæ*. The under parts are similar in *M. terrænovæ*, *M. pennsylvanicus* from New Brunswick, and in the Prince Edward Island skins. The hind foot in *M. terrænovæ* ranges, according to Bangs, from 22 to 25 mm., while in my specimens it varies from 20 to 23 mm.

On the whole, I think the Prince Edward Island specimens are more similar to *M. terrænovæ* than to *M. pennsylvanicus*, but that they represent an intermediate stage between the two species, to which stage the New Brunswick *pennsylvanicus* skins show a decided approach. The specimens of *M. pennsylvanicus* from New Brunswick, to which I have referred in this comparison, came from the northern portion of the province, in the region of the Tobique River. It would, I think, be premature to attempt to name the Prince Edward Island form without having for comparison a series of skins from the coast of New Brunswick, opposite Prince Edward Island, and also from the Magdalen Islands, which lie in the Gulf of St. Lawrence,

[1] Description of a New Field Mouse from Codroy, Newfoundland, *Proc. Biol. Soc. Washington*, vol. ix, pp. 129–132.

between Prince Edward Island and Newfoundland, about seventy miles northeast of the former.

The meadow mouse was one of the commonest mammals of the island, inhabiting sand bars, salt and fresh marshes, and dike lands, as well as damp, bushy clearings abounding in Juncus. They were most numerous on the Cascumpeque sand bar, near Alberton, a long, low, sandy island grown up with *Ammophila arundinacea*, *Achillea millefolium*, and *Arctostaphilos uva-ursi*, and mostly dry, but with a few brackish ponds which communicated with the sea at very high tides. Here the ground was simply honeycombed by their runways.

6. *Fiber zibethicus.* — A common species along the arms of the sea, which make into the island at many points, and in fresh ponds, etc.

7. *Lepus americanus virginianus* (?). — Rabbits were reported as quite common on the island, but I secured only one. This agrees quite closely with specimens of *americanus* (?) from New Brunswick in the American Museum of Natural History, New York, but according to Bangs [1] it is probably *virginianus*. Not having seen any specimens of the hare from farther north, I have been unable to make a satisfactory comparison.

The pelage of my specimen is changing from the summer to the winter stage.

8. *Sorex personatus.* — A common species, occurring mostly in or near wooded swamps. My specimens agree with those from northern Canada, which are larger than those from Pennsylvania and New Jersey, as pointed out by Miller in his "Mammals of Ontario," already mentioned, thus showing perhaps an approach to the Alaskan form *S. streatori*.

The average size of twenty-eight adults is: total length, 103; tail, 45; hind foot, 12.

9. *Sorex hoyi.* — Three specimens of this shrew were all that I secured. They were trapped in or near swampy woods. According to measurements of a number of these shrews from other localities, my specimens are slightly smaller than the average *hoyi*. The average of my specimens is: total length,

[1] The Eastern Races of the American Varying Hare, *Proc. Biol. Soc. Washington*, vol. xii, pp. 77–82.

86; tail, 30; hind foot, 9. The average of five specimens from Ontario (see "Mammals of Ontario," Miller) is: total length, 92; tail, 32; hind foot, 10. (I do not quote any other measurements here, because they were not made in the flesh and are consequently not reliable.)

10. *Blarina brevicauda.* — Only two specimens were secured, both being taken in a small strip of woods bordering a marshy pond at Kensington.

Hypothetical List.

While the following species did not come under my own observation, I obtained records of them from several observers whom I considered trustworthy.

1. *Tamias striatus.* Fairly common. The chipmunks had probably hibernated before I reached the island.
2. *Sciuropterus sabrinus.* Very rare.
3. *Lynx* ————————. Very rare.
4. *Vulpes fulvus.* Fairly common.
5. *Ursus americanus.* Occurred formerly.
6. *Lutra canadensis.* Few.
7. *Putorius vison.* Fairly common.
8. *Mustela americana.* Very scarce.

A curious feature of the mammal life of the island is the absence of porcupines and skunks, neither of which, according to reports from several observers, occur on the island, though both are said to occur on the mainland opposite.

All measurements in this paper are in millimeters.

In conclusion I desire to thank Dr. J. A. Allen and Mr. S. N. Rhoads for access to the collections of mammals in their care for comparison.

THE CACTUS BEES; GENUS LITHURGUS.

T. D. A. COCKERELL.

THE common cacti (*Opuntia* and *Echinocactus*) of New Mexico and adjacent regions are freely visited by bees, the females carrying pollen and undoubtedly aiding cross-fertilization. Professor Toumey, who doubtless knows more about cacti in a state of nature than any other man living in this country, has observed and reported the bee visits, without, however, identifying the bees. He has, however, also observed that most of the common cacti (*Opuntia*) about Tucson, Arizona, propagate by means of falling joints which take root, and not by seed ; and, as he showed me in his cactus garden last year, certain species have almost lost the power of producing seed. The cactus side of the matter will, I trust, be fully elaborated in due time by Professor Toumey, and I only refer to it now to bring forward the interesting fact that we have a group of plants which are in large part independent of sexual reproduction, but which at the same time possess flowers undoubtedly adapted to bees, and visited by a series of bees more or less peculiar to them. The explanation of this will, I think, be given by Professor Toumey, but in the meanwhile it will be useful to record the bee visitors. The following are the *Lithurgus* records for New Mexico:

(1) *Lithurgus echinocacti* Ckll., 1898. — Two females at flowers of *Echinocactus wislizenii*, one at Mesilla Park (campus of Agricultural College), August 22 (Ckll.), one at La Cueva, Organ Mountains, September 4 (*Townsend*).

(2) *Lithurgus gibbosus* Smith, 1853 (n. syn. *compressus*, Smith, ♂). — Our form has clearer wings than Smith's type. Las Cruces, at flowers of *Opuntia engelmanni*, May 26, 4 ♀, May 25, 1 ♀ ; May 24, 1 ♂ ; also observed many other times ; both sexes, but especially males, also common at flowers of *Chilopsis linearis* (Bignoniaceæ), May 31 and June 5 ; Mesilla,

June 19, at flowers of *Cnicus*, 1 ♀; West Fork of Gila River, July 17 (*Townsend*), 1 ♀.

(3) *Lithurgus apicalis* Cresson, 1875. — Santa Fé, June 20, at yellow *Opuntia* flowers, 2 ♂; August 2, at flowers of *Cleome serrulata* (Capparidaceæ), 1 ♂; Santa Fé Cañon, August 11, 7700 ft., inside flowers of *Opuntia arborescens* in wet weather, males; 7600 ft., at flowers of *Cnicus ochrocentrus* (purple-flowered form), females; West Fork of Gila River, July 16, both sexes (*Townsend*). The insect formerly reported from the Mesilla Valley as *apicalis* is *gibbosus*.

These are not the only bees which habitually visit cacti. *Heriades* (*Trypetes*) *gracilior* Ckll., and *Ashmeadiella opuntiæ* (Ckll.) visit the flowers of *Opuntia* in the Organ Mountains in May; while *Ashmeadiella cactorum* (Ckll.) visits *Cactus* (*i.e. Mammillaria*) at Santa Fé in July.[1]

New Mexico Agricultural Experiment Station,
Mesilla Park, N. M., Feb. 25, 1900.

[1] Since the above was written I have found the bee *Agapostemon texanus* Cress., ♀, visiting flowers of *Cereus polyacanthus* Engelm., det. Wooton, and of *Cereus* sp., prob. *fendleri*, Engelm., in the Mesilla Valley; it burrows down among the stamens so as to be quite lost to sight. Another green bee, *Augochlora neglectula* Ckll., was found by Townsend at La Cueva, Organ Mts., visiting flowers of *Echinocactus wislizenii*.

THE ADVANCE OF BIOLOGY IN 1897.

C. B. DAVENPORT.

THE delay in issuing the magnificent volume of *L'Année biologique* for 1897 is regrettable; but the labor involved in bringing the work of the year into a condition where the result will be quickly accessible is clearly tremendous and the standard of the editors seems to rise from year to year. As in the two previous years, I shall briefly sketch some of the results on which the editors lay most stress.

Cytology. — Important advances were made, especially by Kossel and his pupils in the chemistry of the more active proteids of the cell, and particularly of the spermatozoön. The theory that the centrosome is the center of the cell movements in general received support from its relation to the tail of the spermatozoön and probably (as a series of microsomes) to the cilia of epithelia. The variations in the constitution of the spindle, out of continuous and discontinuous fibres, was made clear. The mechanics of mitosis were further illustrated by the behavior of artificial mixtures and of machines; further evidence for the dependence of membrane formation upon the presence of the nucleus was brought forward.

The Sexual Products and Fecundation. — The variability of the process of chromatin reduction was made clear by the demonstration of the absence of a longitudinal division of the chromosomes, in one instance, and of the absence of any sort of reduction in a second (Lee); the transformations of chromatin during the growth of the ovum were further studied; the idea that polar globules are only aborted eggs received support from Francotte's observation that in polyclads they may be fertilized and develop into gastrulæ. Ivanzov interpreted maturation as an extrusion of ferments that might otherwise destroy the spermatozoön. The conclusion that the centrosome occupies the middle-piece of the spermatozoön gained a general

acceptance. The presence of antherozoid in gymnosperms was demonstrated.

In the field of *fertilization* studies, the opinion that the centrosome of the fertilized egg comes exclusively from the sperm was still dominant, despite the contradiction of Myzostoma; but the continuity of the centrosome was still debated.

Parthenogenesis. — A difference in structure between the parthenogenetic and the sexual egg of Rotifera was affirmed, and it was asserted that while in the female parthenogenetic egg of Rotifera only one polar globule is formed, two are permanently extruded when the parthenogenetic egg is destined to produce a male.

Asexual Reproduction. — It has long been recognized that the organs of an individual produced by budding or fission develop differently from those of an egg-individual. This difference can be referred to the dissimilarity of external conditions in the two cases. Thus von Bock showed that in dividing Chætogaster the mouth of the new zoöid arises from two lateral invaginations instead of one ventral one, because the ventral position of the nerve cord interferes with a median invagination. Heschler showed that the regenerative capacity of the earthworm is greatest in the region where autotomy normally occurs. Bordage extended our knowledge of autotomy in Orthoptera.

Ontogenesis. — Echoes of the preformation-epigenesis controversy continued. Fischel, working with isolated blastomeres of ctenophores (Beroë), concludes that they afford a good example of preformation. Attempts to influence development by external means were richly rewarded. Hertwig transformed the holoblastic egg of the frog into a meroblastic one by condensing the yolk by means of a centrifugal machine. It was shown that salamander eggs reared in the dark became in certain particulars abnormal, and that electric rays accelerate the respiration of the eggs of the silkworm and hasten their hatching.

Teratogenesis. — Especially important is the experiment of Tornier, by which doubly and triply tailed lizards may be produced by making a triangular incision through the muscles and into the vertebræ. Also if a limb is transsected and a thread

be tied so as to divide the free surface of the stump, two appendages will arise. A lesion of the humerus may provoke the development of an extra limb.

Regeneration. — It was shown by Miss Peebles that in Hydra there are slight differences in the regenerative capacity of the different parts of the body, since the foot regenerates less well than the lateral parts of the trunk; also that $\frac{1}{200}$ of a Hydra will regenerate. Morgan enumerated certain laws of regeneration of the earthworm. The parallelism of regeneration and ontogeny was still debated. The truth that the essence of regeneration is not the restoration of some lost part, but the reassumption of the specific form, was illustrated by the regeneration of a jellyfish and a hydroid.

Grafting. — As the results of Born and Jœst marked respectively the years 1895 and 1896, so those of Crampton on the pupæ of Lepidoptera marked 1897. In Lepidoptera, as in tadpoles and earthworms, the grafted pieces, even if belonging to distinct species, exert no mutual effect. In plant grafting, however, Daniel got a reciprocal effect.

Sex. — No important advance in this subject was made in 1897. Nussbaum, working on rotifers, got in some cases, as Maupas did, a predominance of females. This was due, Nussbaum thinks, to an excess of food rather than a low temperature, as Maupas concluded.

Polymorphism and Metamorphosis. — The most interesting result was the rearing of an Amblystoma to the adult stages with retention of gills, by means of good food and a high temperature.

Correlation. — False correlation was studied and measured by Pearson and discussed by Galton. Warren determined quantitatively the correlation between the various parts of the human skeleton.

General Morphology and Physiology. — Contributions were made opposing the old interpretation of the germ layers. The science of general physiology was becoming outlined with the aid of new text-books. The importance of ions in physiology received new and stronger confirmation; the correlation between the composition of milk and the rate of infantile develop-

ment of various species was demonstrated. The important rôle of water in growth was pointed out. Nencki (following Tschirsch, '96) showed that the close relation between chlorophyl and hæmoglobin indicated their phylogenetic development out of one fundamental substance before animals and plants diverged. The organic food taken up by plants through their roots was further studied, and the old theory that plants feed exclusively on inorganic compounds received many hard blows. These discoveries, taken with the facts of the fundamental rôle of inorganic salts for animal nutrition, are breaking down the old distinctions drawn between animal and plant nutrition. Further valuable studies were made on the formation of albumen in plants. Muscle contraction, the electric organs, inflammation of wounded plants were newly studied. Dubois afforded much new data on hibernation. The literature on ferments grew rapidly, but not faster than the importance of the subject warrants. The reactions of organisms to light, heat, gravity, and electricity were further studied (Jennings, Loeb, and others). Czapek gives an account of the chemical differences between stimulated and unstimulated plant protoplasm.

Heredity. — Little was done on the important question of inheritance of the acquired. Whitman showed that in hybrid pigeons the period of incubation was the same as in the normally fertilized egg of the female species, and was uninfluenced by the fact that the species of the male was shorter brooded. Early developmental processes, then, are determined by the cytoplasmic peculiarities of the egg. Other experiments in hybridization were made.

Variation. — Applications of the quantitative methods of studying variation to particular problems began to appear. Brewster showed that those characters which are most variable in the individuals of a species are especially those in which the species of a genius differ. Bumpus found the house-sparrow, introduced into America, more variable than in Europe and concludes that its greater variability is the result of the partial withdrawal of natural selection.

Origin of Species. — Noteworthy are the book of Romanes on Darwinism, and C. L. Morgan and H. F. Osborn's theory of

evolution. Many workers pleaded for an explanation of adaptation on the basis of self-adjustment. No real progress was being made in this field, because the method was bad.

Geographic Distribution. — There was especial activity in the study of marine and fresh-water plankton and the theory of bipolarity in the distribution of faunas. Of general works may be cited Lydekker on mammals in general and Sclater on marine mammals.

Mental Functions. — The review of the literature in this department occupies one-fifth of the book. The work is too voluminous and technical to be summarized here.

General Theories. — Very little. A duel between Hertwig and Roux over the word "Entwickelungsmechanik." A suggestive work by Pearson on "The Chances of Death."

General biology has this year made its greatest advances in the study of variation, grafting, in general physiological problems, and in the chemistry of vital phenomena.

ON THE INTERPRETATION OF UNUSUAL EVENTS IN GEOLOGIC RECORDS ILLUSTRATED BY RECENT EXAMPLES.[1]

FREDERIC W. SIMONDS.

An examination of many geologic reports will not fail to show that the working geologist, as a rule, devotes but little time to the interpretation of events, though the most valuable data may be furnished by the very rocks which, as a stratigrapher, he indicates on his map or describes in his notebook. To search out relations of rocks stratigraphically is, of course, one thing; to picture in the mind the conditions that prevailed at the time of their deposition is another and a different thing. But while none will dispute the value of stratigraphic work, the value of interpretation should not be underestimated, for by it we gain our clearest insight into the physical conditions of the past. That it is to a great extent theoretical may be admitted, yet the results of indirect evidence may approximate the truth. In this paper it is my purpose to show that under some conditions, especially when unusual events have been recorded, there is not only difficulty in making the proper interpretation, but even danger that the interpretation may become misleading — a partial truth being, under some circumstances, conducive to positive error.

Throughout the various ages of the earth, as represented by sedimentary deposits, faunas have succeeded faunas, and floras have succeeded floras. At times the exuberance of life must have been great, so numerous are the imbedded remains; but whether numerous or scarce, they are especially useful to the working geologist in that they enable him to recognize strata. As fossils they are figured and described by the paleontologist, who views them mainly from a biologic standpoint. They also

[1] Read before Section E, Geology and Geography, American Association for the Advancement of Science, August 23, 1899.

furnish valuable data in solving problems of descent and explain to the biologist certain obscure points in the structure of living forms. But they afford evidence of another kind, the value of which is determined by the ability of the observer to make a correct interpretation. They may reveal much concerning the habits of species, whether terrestrial or aquatic, and their habitat ; they may give clues to temperature and other details upon which climate depends; they may indicate, if the species be aquatic, the nature of the water, whether fresh, salt, or brackish, whether shallow or deep, whether cold or warm, etc. It is from his knowledge of existing conditions of life and growth that the observer is able to interpret the conditions attendant upon certain characteristic growth of the past : that, for example, bright, clear skies, and pure sea-water, of not too great depth and free from the chilling influence of cold currents, are conducive to a profusion of coral growth ; that alternate exposure to sea and air is satisfactory to mussels and other littoral species ; that clams thrive best in the sand and mud banks exposed between the tides. Knowledge of this kind enables the acute observer to gain a certain amount of *historical* insight, when kindred forms are found in strata, concerning the conditions that have prevailed upon the earth in remote times of which there is left no direct record.

It must be admitted, also, that a correct interpretation involves much evidence other than that afforded by organic remains. The rocks themselves, irrespective of their fossil contents, afford most valuable data respecting the conditions attendant upon their deposition : mud, for instance, indicating turbulent times, erosion and waste of land surfaces, heavy rainfalls, swollen rivers, and flooding ; foraminiferal ooze and other fine-grained calcareous matter, deep-sea deposits ; sand and gravel, beach deposits. Data of this kind are not to be ignored ; nor are those changes, such as the thickening and thinning of strata, the passage of limestone beds into shale or sandstone, or the reverse, which may indicate that the deposition had taken place near to or far from land masses. The information thus derived is to be woven into the record ; it is essential for a complete interpretation.

As a student of geology I was long ago impressed with the masterly interpretation of the Brier Hill Coal Seam of Ohio as presented in the *School of Mines Quarterly* (April, 1883) by the late Professor Newberry. The plan, it seemed to me, was admirable. First, the facts were given ; then, from them, was translated the history. The statement of facts is a matter dependent upon observation ; it may be full and minute, or of a more general nature, according to the care and skill of the observer. Facts relative to the occurrence of coal in a certain area may be simply recorded as facts, a plan pursued in many geologic reports, which is eminently proper from an economic standpoint, as it enables the practical man to locate seams, and that is all he desires. But, from the standpoint of pure science, where *knowledge* is the object to be attained, and not wealth, the point of view is different. The facts must be made to reveal more than the order of succession of strata, the areas covered, the thickness and kinds of rock composing the individual layers; they must be interpreted, and this must be, to a great extent, the work of the *imagination*, the revivifying of a skeleton by the addition of flesh.

This, the *speculative* side of geology, if I may so call it, is particularly attractive to some scholars. It cultivates the same faculties, employs the same modes of reasoning, so widely used by the ethnologist, who, from the exhumed remains, ornaments, utensils, from the shell heaps and rude weapons, learns much of the habits — the life — of extinct peoples.

Granted, then, that much must be speculative, and purely so, he is the best interpreter who can bring his imaginary picture nearest in accord with facts. Ultimately, then, the interpretation is resolved into a matter of probability, based upon data furnished by observation, but it is, nevertheless, a creation of the mind. Herein lies one of the greatest difficulties: conceded that the observations have been carefully and properly made, extreme caution must be employed in drawing conclusions, lest, by a *mental* slip, error and not truth be the result.

As I have already intimated, the proper interpretation of paleontologic evidence, supplemented by the data furnished by the rocks themselves, gives us a somewhat definite idea of the

climate and other physical conditions of a past age, acquaints us with the habits and habitat of species, whether animals or plants, and elucidates many interesting and intricate points concerning their growth, development, and distribution; in short, it enables us to reanimate and reëstablish that age. But all of this must be done, directly or indirectly, in accordance with the light of the present time. We have, it is true, familiarized ourselves with usual events, yet we know that the unusual does sometimes happen, and if now, why not in the past?

That an unusual event in the paleontologic record, judging entirely from present events, might be a source of considerable difficulty, or of positive error in interpretation, cannot be doubted. Let me illustrate: Some years ago, as the result of a heavy storm, fish in large numbers were thrown ashore in certain localities bordering on the Bay of Fundy. Let us suppose this to be a region of rapid sedimentation and that their remains were quickly entombed. Had this event taken place in another age, and had the sediment afterwards been elevated and lithified, then would these remains have afforded suitable material for interpretation. But what should the translation indicate? An unusual abundance of fish — conditions favorable to the growth and development of this form of life which had been suddenly interrupted? If that, the whole truth would not be told. By an unusual event, *viz.*, a heavy storm, fish remains that under ordinary circumstances would have been distributed over a wide area are accumulated within a small area, and, further, remains that under normal conditions would have ranged through a considerable space vertically, are limited to a single layer or a few layers of the deposit. Under such conditions the abundance of fish is apparent rather than real. Other interpretations might be made; that, for instance, owing to an epidemic, fish perished in large numbers; or, again, that a sudden and great decrease in temperature caused the marked fatality.

It will be seen that while each of the above interpretations appears adequate to account for the phenomenon, none have given the complete truth, though in all the occurrence of *an*

unusual event has been recognized. The action of the heavy storm is the truth sought but not brought out.

It is fortunate that as the result of an unusual occurrence witnessed by Dr. Joseph Le Conte a rational explanation can be made of the conditions under which insects may be collected in vast numbers within the confines of a single stratum. As ordinarily interpreted, the contents of such a bed would indicate that this particular form of life existed in greater abundance at the time of its deposition than either before or after; whereas, as shown by Dr. Le Conte, the abundance of insect remains may be due to concentration — a perfectly natural result though brought about by unusual conditions. He says:

"On Lake Superior, at Eagle Harbor, in the summer of 1844, we saw the white sands of the beach blackened with the bodies of insects of many species, but mostly beetles, cast ashore. As many species were here collected in a few days, by Dr. J. L. Le Conte, as could have been collected in as many months in any other place. The insects seem to have flown over the surface of the lake; to have been beaten down by winds and drowned, and then slowly carried shoreward and accumulated in this harbor, and finally cast ashore by winds and waves. A small river emptying into the harbor carried also many beetles and ants. Doubtless," he continues, "at Oeningen, in Miocene times, there was an extensive lake surrounded by dense forests, through which ran a small river emptying into the lake; and the insects drowned in its waters, and the leaves strewed by the winds on its surface, were cast ashore by its waves."[1]

Again, at the mouth of the Mackenzie River a vast quantity of driftwood is accumulating at the present time, which Sir Charles Lyell long ago predicted would, at some distant period, form a great deposit of coal. Now this accumulation of vegetable matter is that having its origin in a much warmer and well-wooded region. By the flooding of a great stream it is conveyed to its final resting place, which is a locality both climatically and biologically different — a region of low temperature and scant vegetation. Let us suppose that the buried

[1] *Elements of Geology*, Fourth Edition, p. 534.

accumulation has become coal. An interpretation that the contained tree-trunks represented the vegetable life of that region would be, in the highest degree, erroneous. The lowly terrestrial plants of the vicinity may have entirely disappeared, or their remains, commingled with those of a forest vegetation, may attract little or no attention. Granted, however, that the alluvial barriers may be discovered, that the true character of the deposit may be determined, still there is an unusual event to be translated, namely, the enormous distance the vegetable matter has been transported. To recognize this may be extremely difficult, if not impossible. During the lapse of time, elevation and folding may have taken place; denudation and erosion may have completely altered the topography of so vast an area of country; parts of the great river basin may have become so widely separated that their continuity would scarcely be suspected. This is not an exaggerated statement; on the contrary, it lies strictly within the limits of possibility. If so, then is the danger of misinterpretation clearly shown.

The flooding of streams, it is said, is often quite destructive of fish life; the copious sediment contained in the water being an undoubted cause of suffocation. During the recent flood in Texas I saw fish so overcome that they were easily taken by hand. When the waters receded their dead bodies were reported as occurring along the river banks and on the bars. Under such conditions it does not seem improbable that parts of the skeleton, and especially the scales, such as those of the ganoid type, should be borne seaward, and finally deposited in salt water, commingled with marine forms. Had a similar circumstance occurred in other than recent time, and had the remains of marine and fresh-water forms been preserved in the same stratum, then a fine discrimination between animals greatly alike in appearance, and, possibly, not presenting characters admitting of direct relations with the present, becomes necessary on the part of the observer would he make a correct interpretation. And, moreover, this hypothetical statement will serve to emphasize the fact that a knowledge of biology is of prime importance to him who would undertake the interpretation of such a record.

Cases might be multiplied, but the point I wish to make is apparent: an interpretation of the history recorded in strata is an absolute necessity if we are to picture the past. Recorded facts must be made to reveal unrecorded events. It is only from the conclusions drawn that we can give the picture life; if they be wrong, the picture becomes distorted, perchance a monstrosity. Unusual events now happen, hence our right to believe that they have happened in the past. They are at times shrouded in deep obscurity — hidden, it may be, in a mass of intricate details. Often they are confined to a single locality, but they may affect an unusually large area. However this may be, the greatest care is necessary lest we pass them by unnoticed, and the greatest caution, should they be discovered, lest we misinterpret them. Human speculation does not always admit of proof, but when based upon facts, as it should be in geologic interpretation, it may at least approximate the truth.

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SYNOPSES OF NORTH-AMERICAN INVERTEBRATES.

X. The Oxyrhynchous and Oxystomatous Crabs of North America.

MARY J. RATHBUN.

The Oxyrhyncha include the large family of Maiidæ, or "spider crabs," so called on account of their slender legs. The body is usually narrow in front, sometimes suborbicular, but always with a beak or rostrum, as in the common "spiders" (Libinia) of the Atlantic coast. The Maiidæ are all provided with numbers of hairs, either hook-shaped or straight, varying in form and arrangement in the different genera and species. In order to conceal themselves from enemies these crabs cover their backs with algæ and sedentary animals, as sponges, tunicates, and bryozoans, which are held fast by the hairs and live and grow until their host is unrecognizable. This is notably so in *Oregonia gracilis*. Some species, as those of Collodes, are covered with slimy adherent mud.

The Parthenopidæ, the second and smaller division of the Oxyrhyncha, are easily distinguished by their broad, triangular carapace, very long, usually trigonal chelipeds, and short, delicate walking legs. They often resemble fragments of stone with sharp angles, or with eroded or nodular surfaces.

The Oxystomata comprise several families widely different in their general appearance. Of the Calappidæ the best known are the species of Calappa, "box crabs," or "shamefaced crabs," from the chelipeds which are large and of unusual shape, with cockscomb-like crests on the upper margin of the hands, and which in flexion are pressed tightly against the inferior surface of the carapace like a shield. This arrangement is said to protect from attack any morsels of food they may be devouring.

The Calappa lives usually on sandy shores, into which it is in the habit of burrowing.

Of the Matutidæ, which are sparsely represented in North America, the species of Hepatus are large and strikingly colored. They differ from Calappa in the smaller claws and in the narrower posterior portion of the shell. *Hepatus epheliticus* is known on the Gulf coast as "Dolly Varden."

The Leucosiidæ are generally distinguished by their globular carapace, long claws, and comparatively small walking feet. The largest and most conspicuous North-American species are the *Persephona punctata*, or "speckled spider," of the Atlantic and Gulf coasts, and *Randallia ornata* of the Pacific coast.

The Dorippidæ are marked by the reduction of the last two pairs of feet, which are raised on the dorsal surface of the carapace. The first two pairs of walking legs are long, enabling the crab to run fast.

In the key which follows, the same terms are used to indicate distribution as in No. VII of these synopses; and, as in that number, many of the definitions have been taken from the works of Drs. Stebbing and Alcock.

TRIBE OXYRHYNCHA, OR MAIOIDEA.

Carapace narrowed anteriorly and rostrate, with the hepatic regions small, the branchial large. Epistome generally large. Buccal frame quadrate, with anterior margin straight. Nine pairs of branchiæ, with the efferent channels opening at the sides of the endostome. The afferent channels open behind the pterygostomian regions, in front of the bases of the chelipeds. First antennæ longitudinally folded. Third maxillipeds with the fifth joint articulated at the apex or at the front inner angle of the fourth. The genital organs of the male are inserted at the bases of the last pair of trunk legs.

KEY TO THE FAMILIES OF THE TRIBE OXYRHYNCHA.

A. Basal joint of antennæ well developed. Chelipeds not a great deal longer than the other legs . . . . . MAIIDÆ Leach

A'. Basal joint of antennæ very small, and imbedded between the front and the floor of the orbit. Chelipeds a great deal longer and more massive than the other legs

PARTHENOPIDÆ Milne-Edwards, White

KEY TO THE GENERA OF THE FAMILY MAIIDÆ.

A. Basal joint of antennæ extremely slender throughout its length and usually long. Eyes without orbits and not concealed.

B. Carapace elongate, narrowed in front. External maxillipeds somewhat pediform, with the palp large and coarse, and the merus often narrower than the ischium. Basal joint of antennæ usually subcylindrical.

C. Rostrum extremely long. Dactyli of ambulatory legs longer than the propodi.

D. Carapace smooth, even above. Antennæ concealed beneath the rostrum . . . . . Stenorynchus

D'. Carapace uneven above. Antennæ long, flagellum exposed . . . . . Metoporhaphis

C'. Rostrum short. Dactyli of ambulatory legs shorter than the propodi . . . . . Podochela

B'. Carapace usually subtriangular. External maxillipeds with the merus at least as broad as the ischium, and the palp small. Basal joint of antennæ flattened or concave ventrally.

C. Rostrum simple, or with two short spines or lobes.

D. No postocular spine or tooth.

E. Chelipeds not much elongated, palms inflated. Rostrum emarginate . . . . . Æpinus

E'. Chelipeds much elongated, with palms long and slender. Rostrum simple . . . . Erileptus

D'. A postocular spine or tooth.

E. Eyes long and slender . . . . . Arachnopsis

E'. Eyes not long and slender.

F. Inner crest of basal antennal joint very prominent and projecting downward at right angles to the outer crest.

G. Postocular tooth pointing forward.

H. Postocular tooth fitting close to the eye . . . . . Dasygyius

H'. Postocular tooth not fitting close to the eye . . . . . Inachoides

G'. Postocular tooth pointing outward Collodes

F'. Inner crest of basal antennal joint, when present, not projecting downward at right angles to the outer crest.

G. Rostrum simple . . . . . Anasimus

G'. Rostrum bifid.

H. Spine of basal antennal joint not advanced to the line of the front.

Hepatic region approximating the eye, its anterior margin transverse Batrachonotus

H'. Spine of basal antennal joint advanced to the line of the front or nearly so. Hepatic region distant from the eye, its anterior margin oblique Euprognatha

C'. Rostrum composed of two long spines . . . . Oregonia

A'. Basal joint of antennæ not extremely slender, often very broad. Eyes with orbits, or capable of concealment.

B. Basal joint of antennæ truncate-triangular. Eyes without true orbits; eyestalks very short, either concealed beneath a supra-ocular spine or sunk in the sides of a huge beak-like rostrum.

C. Antennæ concealed beneath the rostrum.

D. Rostrum formed of two long contiguous horns Sphenocarcinus

D'. Rostrum not formed of two long contiguous horns.

E. Eyes immovable . . . . . Mocosoa

E'. Eyes movable . . . . . Epialtus

C'. Antennæ not concealed beneath the rostrum.

D. Entire lateral portion of carapace wing-like. Carapace smooth or nearly so . . . . . Mimulus

D'. Carapace with two large lobes or teeth on each side. Carapace tuberculate . . . . . Pugettia

B'. Basal joint of antennæ broad, usually either extensively produced outward or, often, with one or two distal spines. Eyes with orbits.

C. Orbits with a large, blunt, cupped postocular process into which the eye is retractile, but is not completely concealed. Eyestalks short.

D. No preocular spine.

E. Meral joints of ambulatory legs flattened.

F. Carapace nearly as broad as long; surface uneven . . . . . Chionœcetes

F'. Carapace much longer than broad; surface smooth . . . . . Pelia

E'. Meral joints of ambulatory legs subcylindrical Hyas

D'. A preocular spine.

E. Ambulatory legs armed with spines . . . Nibilia

E'. Ambulatory legs not armed with spines.

F. Basal joint of antenna deeply concave; second and third joints flattened, with thin, broad, lateral expansions . . . . . Scyra

F'. Basal joint of antenna not deeply concave; second and third joints not broadly expanded.
G. Rostral horns long and slender . Chorilia
G'. Rostral horns not long and slender.
H. Basal antennal joint narrowing distally . . . . . Rhodia
H'. Basal antennal joint not narrowing distally . . . . . Loxorhynchus
C'. Orbits complete, often tubular, completely concealing the retracted eye.
D. Meral joints of ambulatory legs with very broad laminate expansions . . . . . Hemus
D'. Meral joints of ambulatory legs without laminate expansions.
E. Fingers spoon-shaped at tips.
F. Carapace suboblong or suboval. Orbits directed forward. First movable joint of antennæ broadly expanded. Legs unarmed Pitho
F'. Carapace subtriangular. Orbits directed obliquely forward. First movable joint of antennæ not broadly expanded. Legs spinous . . . . . Mithrax
E'. Fingers acute at tips.
F. Orbits tubular, directed outward. Carapace subtriangular or oblong.
G. Carapace with lateral spines Stenocionops
G'. Carapace without lateral spines Macrocœloma
F'. Orbits not tubular, directed obliquely forward. Carapace orbicular.
G. Basal joint of antennæ with two spines on the inferior margin of the orbit Cœlocerus
G'. Basal joint of antennæ without spines on the inferior margin of the orbit Libinia

THE SPECIES OF MAIIDÆ.

Genus Stenorynchus Lamarck . *S. sagittarius* (Fabricius), *M(CH)SG*
Genus Metoporhaphis Stimpson . . . *M. calcarata* (Say), *M(CH)SG*
Genus Podochela Stimpson.

Key to Species.

A. Rostrum acute or spiniform.
  B. Rostrum long-pointed, terminating in a slender spine
    P. gracilipes Stimpson, *M(CH)SG*
  B'. Rostrum short-pointed, not terminating in a spine.
    C. A large postorbital tooth near the eye
      P. lamelligera (Stimpson), *G*
    C'. A small postorbital tubercle, remote from the eye
      P. hemphillii (Lockington), *D*
A'. Rostrum not acute, but rounded.
  B. Pterygostomian region with a laminate crest. Basal antennal joint with lateral crests laminate *P. riisei* Stimpson, *M(CH)G*
  B'. Pterygostomian region with a tubercle. Basal antennal joint with lateral crests smooth and rounded *P. hypoglypha* (Stimpson), *G*

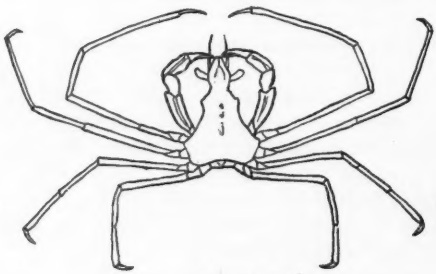

FIG. 1. — Podochela riisei.

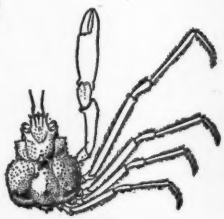

FIG. 2. — Euprognatha rastellifera.

Genus Æpinus Rathbun . . *A. septemspinosus* (A. Milne-Edwards), *G*
Genus Erileptus Rathbun . . . . . *E. spinosus* Rathbun, *D*
Genus Arachnopsis Stimpson . . . . . *A. filipes* Stimpson, *G*
Genus Dasygyius Rathbun . . . . *D. tuberculatus* (Lockington), *D*
Genus Inachoides Milne-Edwards Lucas . *I. magdalenensis* Rathbun, *D*
Genus Collodes Stimpson.

Key to Species.

A. Carapace with median spines
  C. depressus A. Milne-Edwards, *M(CH)SG*
A'. Carapace without median spines.
  B. Interantennular spine advanced as far as the rostrum
    C. leptocheles Rathbun, *G*
  B'. Interantennular spine not advanced as far as the rostrum
    C. robustus Smith, *M*

Genus Anasimus A. Milne-Edwards.

Key to Species.

A. Ambulatory legs more than twice the length of the carapace
A. latus Rathbun, *SG*

A'. Ambulatory legs less than twice the length of the carapace
A. rostratus Rathbun, *D*

Genus Batrachonotus Stimpson . . . *B. fragosus* Stimpson, *M(CH)G*
Genus Euprognatha Stimpson . . . . *E. rastellifera* Stimpson, *MS*
Genus Oregonia Dana . . . . . *O. gracilis* Dana, *AP*
Genus Sphenocarcinus A. Milne-Edwards
S. corrosus A. Milne-Edwards, *M(CH)*
Genus Mocosoa Stimpson . . . . . *M. crebripunctata* Stimpson, *G*
Genus Epialtus Milne-Edwards.

Key to Species.

A. First tooth of the antero-lateral margin large and prominent.
B. No postocular tooth . . *E. bituberculatus* Milne-Edwards, *D*

FIG. 3. — Epialtus productus.

B'. A postocular tooth . . . . . *E. productus* Randall, *APD*
A'. First tooth of the antero-lateral margin small, not prominent
E. nuttallii Randall, D
Genus Mimulus Stimpson . . . . . *M. foliatus* Stimpson, *APD*
Genus Pugettia Dana.

Key to Species.

A. Postorbital projection a triangular tooth.
B. Hepatic expansion very broad . . . *P. gracilis* Dana, *APD*[1]
B'. Hepatic expansion narrow, transverse . . *P. richii* Dana, *AD*

[1] San Luis Obispo, California (Lockington).

A'. Postorbital projection an obtuse lobe . . . . *P. dalli* Rathbun, *D*

Genus Chionœcetes Krøyer.

Key to Species.

A. Carapace tuberculous; branchial regions flattened
C. opilio (O. Fabricius), *NA*

A'. Carapace spinous; branchial regions dilated
C. tanneri Rathbun,[1] *APD*

Genus Pelia Bell.

Key to Species.

A. Hands in male with margins tapering to the fingers, which have their edges meeting throughout . . *P. pacifica* A. Milne-Edwards, *D*

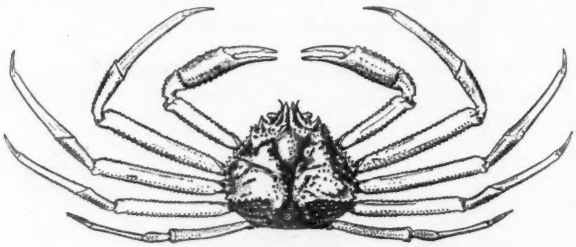

FIG. 4.—Chionœcetes tanneri.

A'. Hands in male with margins subparallel; fingers gaping at base
P. mutica (Gibbes), *MSG*

Genus Hyas Leach.

Key to Species.

A. Carapace subtriangular; hepatic region not dilated laterally. Basal antennal joint subtriangular . . . . *H. araneus* (Linnæus), *N*

A'. Carapace lyrate; hepatic region dilated laterally. Basal antennal joint with sides nearly parallel.

B. Posterior angle of hepatic projection rounded. Basal antennal joint without a large tubercle at the antero-external angle
H. coarctatus Leach, *NMA*

B'. Posterior angle of hepatic projection subacute. Basal antennal joint with a large tubercle at the antero-external angle
H. lyratus Dana, *AP*

Genus Nibilia A. Milne-Edwards
N. erinacea A. Milne-Edwards, *M(CH)G*

Genus Scyra Dana . . . . . *S. acutifrons* Dana, *APD*

Genus Chorilia Dana . . . . . *C. longipes* Dana, *APD*

[1] Only in exceptional cases has this species been found above the 100-fathom line.

Genus Rhodia Bell . . . . . *R. parvifrons* (Randall), *D*
= *Herbstiella camptacantha* Stimpson

Genus Loxorhynchus Stimpson.

Key to Species.

A. Hepatic region with two large spines . . *L. grandis* Stimpson, *PD*
A'. Hepatic region with one large spine . . *L. crispatus* Stimpson, *D*

Genus Hemus A. Milne-Edwards . *H. cristulipes* A. Milne-Edwards, *G*

Genus Pitho Bell.

Key to Species.

A. Carapace smooth, pubescent . . . *P. anisodon* (von Martens), *G*

FIG. 5. — Hyas lyratus.

A'. Carapace tuberculous . . . . . *P. lherminieri* (Schramm), *S*

Genus Mithrax Latreille.[1]

Key to Species.

A. Carapace with dorsal sulci on the branchial regions
M. forceps (A. Milne-Edwards), *M(CH)S*
A'. Carapace without dorsal sulci on the branchial regions.
B. Divisions of rostrum tuberculiform.
C. Tubercles of the carapace faintly indicated
M. hispidus (Herbst), *S*
C'. Tubercles of the carapace well marked
M. pleuracanthus Stimpson, *M(CH)SG*

[1] *M. denticulatus* Bell, *M. tuberculatus* Stimpson, and *Teleophrys cristulipes* Stimpson are recorded from California by Miers, but this is very likely an error, as Miers used "California" and "Lower California" interchangeably.

B'. Divisions of rostrum long and sharp *M. acuticornis* Stimpson, *G* Genus Stenocionops Leach.

Key to Species.

A. Carapace with strong median spines
S. spinosissimus (Saussure), *M(CH)*

A'. Carapace without strong median spines.

B. Carapace smooth . . . . . *S. furcatus* (Olivier), *S*

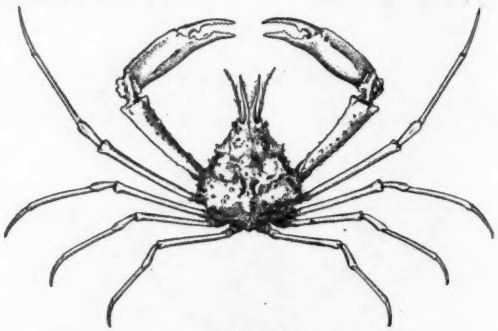

FIG. 6. — Chorilia longipes.

FIG. 7. — Pitho anisodon.

B'. Carapace tuberculous *S. furcatus cælatus* (A. Milne-Edwards), *G* Genus Macrocœloma Miers.

Key to Species.

A. Carapace with dorsal spines besides the epibranchial and posterior spines.

B. Rostrum strongly deflexed *M. septemspinosum* (Stimpson), *SG*

B'. Rostrum almost horizontal . . *M. camptocerum* (Stimpson), *G*

A'. Carapace without dorsal spines except the epibranchial and posterior spines . . . . . *M. trispinosum* (Latreille), *M*(*CH*)*G*

Genus Cœlocerus A. Milne-Edwards . . . . *C. grandis* Rathbun, *G*

Genus Libinia Leach.

Key to Species.

A. Carapace with lateral margin evenly rounded behind the rostrum.

B. Median spines six . . . . . *L. dubia* Milne-Edwards, *MSG*

B'. Median spines nine . . . . *L. emarginata* Leach, *NMSG*

A'. Carapace distended at the hepatic regions *L. spinimana* Rathbun, *G*

FIG. 8. — Mithrax acuticornis.

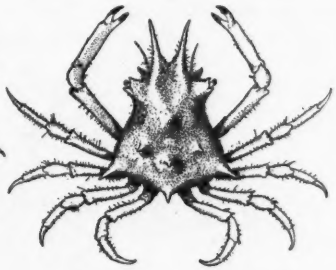

FIG. 9. — Macrocœloma camptocerum.

KEY TO THE GENERA OF THE FAMILY PARTHENOPIDÆ.

A. Carapace not laterally expanded.

B. Carapace tuberculate.

C. Carapace triangular, convex. Pterygostomian and subhepatic regions not deeply excavated to form passages to the efferent branchial apertures . . . . . Lambrus

C'. Carapace subrhomboidal, depressed. Pterygostomian and subhepatic regions excavated, this excavation forming, when the chelipeds are retracted, passages to the efferent branchial apertures . . . . . Platylambrus

B'. Carapace smooth . . . . . Solenolambrus

A'. Carapace more or less expanded to form a vault in which the ambulatory legs are concealed.

B. Carapace greatly expanded, both laterally and posteriorly Cryptopodia

B'. Carapace expanded laterally, but not posteriorly . Heterocrypta

THE SPECIES OF PARTHENOPIDÆ.[1]

Genus Lambrus Leach.

Key to Species.

A. Carapace subtriangular, with lateral angles.

B. Protuberances of the carapace spiniform, subacute
L. pourtalesii Stimpson, *MS*

B'. Protuberances of the carapace tuberculiform, broadly rounded at the top . . . . . *L. fraterculus* Stimpson, *M(CH)G*

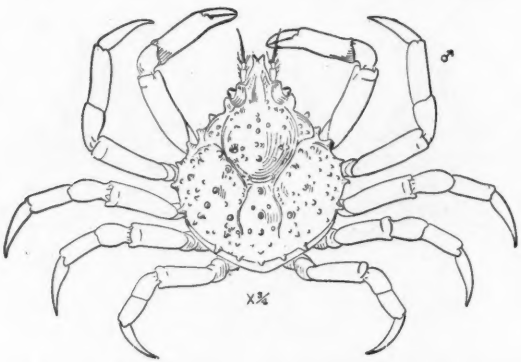

FIG. 10. — Libinia emarginata.

A'. Carapace posteriorly rounded, without lateral angles
L. agonus Stimpson, *G*

Genus Platylambrus Stimpson . *P. serratus* (Milne-Edwards), *M(CH)G*

Genus Solenolambrus Stimpson.

Key to Species.

A. Gastric and cardiac regions with angular ridges
S. decemspinosus Rathbun, *G*

A'. Gastric and cardiac regions without angular ridges
S. tenellus Stimpson, *G*

Genus Cryptopodia Milne-Edwards.

[1] California is given by Owen as the type locality of *Leiolambrus punctatissimus*. As it has not since been recorded north of Lower California, which was known as "California" in 1839, it is inferred that the species does not occur in the United States.

Key to Species.

A. Posterior margin of carapace straight or nearly so. Cardiac region faintly indicated . . . . . *C. concava* Stimpson, *G*

A'. Posterior margin of carapace sinuous. Cardiac region protuberant *C. occidentalis* Dana, *PD*

Genus Heterocrypta Stimpson . . . . *H. granulata* (Gibbes), *SGM*

TRIBE OXYSTOMATA OR LEUCOSOIDEA.

Carapace with the antero-lateral margins arcuate or orbiculate; sometimes subglobose or more or less oblong, with subparallel margins. Epistome much reduced. Buccal frame more or less triangular, produced and narrowed forward, with the margins anteriorly convergent. Six to nine

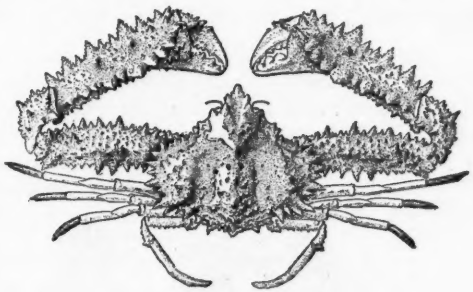

FIG. 11. — Lambrus pourtalesii.

pairs of branchiæ. Efferent channels opening at the middle of the endostome, which is produced forwards. The afferent channels open either behind the pterygostomian regions and in front of the chelipeds, or at the antero-lateral angles of the palate. First antennæ folded longitudinally or obliquely. The genital organs of the male are exserted, either from the bases of the fifth pair of legs, or from the surface of the sternal plastron.

KEY TO THE FAMILIES OF THE TRIBE OXYSTOMATA.

A. Legs normal in size and position.

B. Maxillipeds not closing the buccal cavern; their palp always exposed . . . CALAPPIDÆ Milne-Edwards, de Haan, White

B'. Maxillipeds closing the buccal cavern; the palp hidden.

C. Afferent branchial openings in front of the bases of the chelipeds . . . . . MATUTIDÆ M'Leay

C'. Afferent branchial openings on either side of the endostome LEUCOSIIDÆ Leach

A'. Last two pairs of legs much reduced in size, and having a peculiar position in the dorsal plane of the body
DORIPPIDÆ Milne-Edwards, White

KEY TO THE GENERA OF THE FAMILY CALAPPIDÆ.

A. Antero-lateral margin continuous with the postero-lateral.
B. Carapace broadest in its posterior half . . . . . Calappa
B'. Carapace broadest in its anterior half . . . . . Acanthocarpus
A'. Antero- and postero-lateral margins meeting at an angle armed with a stout spine . . . . . Platymera

THE SPECIES OF CALAPPIDÆ.

Genus Calappa Fabricius.

Key to Species.

A. Teeth of the posterior margin of the carapace broad and shallow
C. flammea (Herbst), *MSG*
A'. Median pair of teeth of the posterior margin long and slender
C. sulcata Rathbun, *M(CH)G*

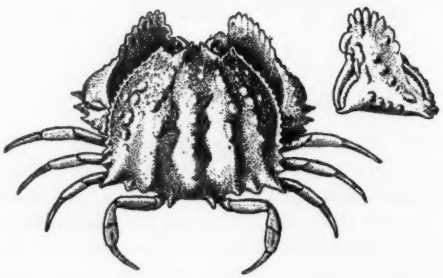

FIG. 12. — Calappa sulcata.

Genus Acanthocarpus Stimpson . . . . *A. alexandri* Stimpson, *MG*
Genus Platymera Milne-Edwards . *P. gaudichaudii* Milne-Edwards, *PD*

KEY TO THE GENERA OF THE FAMILY MATUTIDÆ.

A. Carapace much broader than long; front not produced; surface evenly convex . . . . . Hepatus
A'. Carapace nearly as long as broad; front considerably produced; surface very uneven, nodulose . . . . . Osachila

The Species of Matutidæ.

Genus Hepatus Latreille.

Key to Species.

A. Carapace marked with large patches of color, margined by darker lines. Length of penultimate segment of abdomen of male two-thirds its proximal width . . . *H. epheliticus* (Linnæus), *MSG*

A'. Carapace marked with transverse lines of small, dark spots. Length of penultimate segment of abdomen of male three-fourths its proximal width . . . . . *H. princeps* (Herbst), *S*

Genus Osachila Stimpson . . . . . *O. tuberosa* Stimpson, *G*

Key to the Genera of the Family Leucosiidæ.

A. Merus of external maxillipeds more than half the length of the ischium measured along the inner border. Fingers stout, gradually narrowing from base to tip.

B. Little or no space between the edge of the floor of the orbit and the free edge of the buccal cavern.

C. Intestinal region without a spine. Merus of external maxillipeds nearly as long as the ischium measured along the inner border . . . . . Philyra

C'. Intestinal region with a long spine. Merus of external maxillipeds much shorter than the ischium measured along the inner border . . . . . Persephona

B'. A considerable space between the edge of the lower wall of the orbit and the free edge of the buccal cavern.

C. Carapace almost circular and globular . . . . Randallia

C'. Carapace polygonal; surface very uneven . . . Lithadia

A'. Merus of external maxillipeds half or less than half the length of the ischium measured along the inner border. Fingers slender, almost of the same diameter from base to near tip.

B. Fingers moving in a vertical plane. Pterygostomian channels projecting considerably beyond the orbits . . . Iliacantha

B'. Fingers moving in a horizontal plane. Pterygostomian channels not projecting beyond the orbits . . . . . Myropsis

The Species of Leucosiidæ.

Genus Philyra Leach . . . . . *P. pisum* de Haan, *P*

Genus Persephona Leach . . . . *P. punctata* (Linnæus), *M(CH)SG*

Genus Randallia Stimpson . . . . . *R. ornata* (Randall), *PD*

Genus Lithadia Bell.

Key to Species.

A. A narrow bridge between two cavities connects the cardiac and branchial regions . . . . . *L. pontifera* Stimpson, *M*(*CH*)

A'. No bridge connects the cardiac and branchial regions.

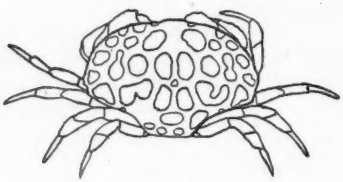

FIG. 13. — Hepatus epheliticus.

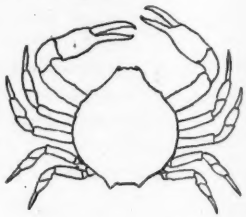

FIG. 14. — Randallia ornata.

B. A transverse ridge between the large branchial protuberance and the lateral margin . . . . *L. cariosa* Stimpson, *M*(*CH*)*G*

B'. A small circular protuberance between the large branchial protuberance and the lateral margin . *L. cadaverosa* Stimpson, *G*

Genus Iliacantha Stimpson . . . . *I. subglobosa* Stimpson, *M*(*CH*)*G*

Genus Myropsis Stimpson . . . . . *M. quinquespinosa* Stimpson, *G*

KEY TO THE GENERA OF THE FAMILY DORIPPIDÆ.

A. The external maxillipeds leave all the anterior part of the buccal cavern uncovered . . . . . Ethusa

A'. The external maxillipeds cover the buccal cavern . . Cyclodorippe

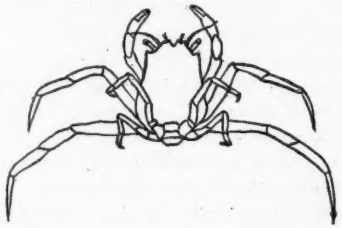

FIG. 15. — Ethusa mascarone.

THE SPECIES OF DORIPPIDÆ.

Genus Ethusa Roux.

Key to Species.

A. Eyestalks long, extending laterally beyond the postorbital spine *E. mascarone americana* (A. Milne-Edwards), *M*(*CH*)*G*

A'. Eyestalks short, directed forward.

B. Dactyli of second and third pairs of legs broad, flattened
E. microphthalma Smith, *M*

B'. Dactyli of second and third pairs of legs slender, not flattened
E. tenuipes Rathbun, *G*

Genus Cyclodorippe A. Milne-Edwards.

Key to Species.

A. Carapace convex. No hepatic tooth *C. nitida* A. Milne-Edwards,[1] *D*
A'. Carapace flattened. A hepatic tooth . . . *C. plana* (*sp. nov.*), *G*

BIBLIOGRAPHY.

The following citations are additional to those given in Synopsis No. VII.

'34 MILNE-EDWARDS, H. Histoire naturelle des crustacés. Vol. i, chap. iii, pp. 266–362, and Atlas.

'37 MILNE-EDWARDS, H. Histoire naturelle des crustacés. Vol. ii, pp. 96–162, and Atlas.

'38 KRØYER, HENRIK. Conspectus Crustaceorum Grœnlandiæ. *Naturhistorisk Tidsskrift.* Series 1, vol. ii, pp. 249–261.

'39 RANDALL, J. W. Catalogue of the Crustacea Brought by Thomas Nuttall and J. K. Townsend from the West Coast of North America and the Sandwich Islands, etc. *Journ. Acad. Nat. Sci. Philadelphia.* Vol. viii, pp. 106–147.

'44 DE KAY, JAMES E. Zoölogy of New York, or the New York Fauna. Pt. vi, Crustacea.

'52 DANA, JAMES D. Crustacea of the United States Exploring Expedition. Vol. i, pp. 75–142, 389–398, and Atlas.

'56 GIBBES, L. R. Monograph of the Genus Cryptopodia. *Proc. Elliott Soc. Nat. Hist.* Pp. 32–38. June 11, 1856.

'70 STREETS, T. HALE. Notice of some Crustacea of the Genus Libinia, with descriptions of four new species. *Proc. Acad. Nat. Sci. Philadelphia.* Vol. xxii, pp. 104–107.

'71 STIMPSON, W. Preliminary Report on the Crustacea Dredged in the Gulf Stream in the Straits of Florida, by L. F. de Pourtalès, Assist. U. S. Coast Survey. Pt. i, Brachyura. *Bull. Mus. Comp. Zoöl.* Vol. ii, pp. 109–160.

'71 STIMPSON, WILLIAM. Notes on North American Crustacea in the Museum of the Smithsonian Institution. III. *Ann. Lyc. Nat. Hist. New York.* Vol. x, pp. 92–136.

[1] Type, No. 14,256, U. S. Nat. Mus., southern California; W. H. Dall.

'77 LOCKINGTON, W. N. Remarks on the Crustacea of the Pacific Coast, with descriptions of some new species. *Proc. Cal. Acad. Sci.* Vol. vii, pp. 28–36. Feb. 7, 1876.

'77 LOCKINGTON, W. N. Remarks on the Crustacea of the Pacific Coast of North America, including a catalogue of the species in the museum of the California Academy of Sciences, San Francisco. *Proc. Cal. Acad. Sci.* Vol. vii, pp. 63 bis–78. July 17, 1876.

'79 MIERS, E. J. On the Classification of the Maioid Crustacea or Oxyrhyncha, with a synopsis of the families, subfamilies, and genera. *Journ. Linn. Soc. London.* Vol. xiv, pp. 634–673, Pls. XII, XIII.

'83 SMITH, SIDNEY I. Preliminary Report on the Brachyura and Anomura Dredged in Deep Water off the South Coast of New England by the United States Fish Commission in 1880, 1881, and 1882. *Proc. U. S. Nat. Mus.* Vol. vi, pp. 1–57, Pls. I–VI.

'92 RATHBUN, MARY J. Catalogue of the Crabs of the Family Periceridæ in the U. S. National Museum. *Proc. U. S. Nat. Mus.* Vol. xv, No. 901, pp. 231–277, Pls. XXVIII–XL.

'93 RATHBUN, MARY J. Catalogue of the Crabs of the Family Maiidæ in the U. S. National Museum. *Proc. U. S. Nat. Mus.* Vol. xvi, No. 927, pp. 63–103, Pls. III–VIII.

'93 RATHBUN, MARY J. Descriptions of New Genera and Species of Crabs from the West Coast of North America and the Sandwich Islands. *Proc. U. S. Nat. Mus.* Vol. xvi, No. 933, pp. 223–260.

'94 RATHBUN, MARY J. Notes on the Crabs of the Family Inachidæ in the U. S. National Museum. *Proc. U. S. Nat. Mus.* Vol. xvii, No. 984, pp. 43–75.

'97 RATHBUN, MARY J. Synopsis of the American Species of Ethusa, with description of a new species. *Proc. Biol. Soc. Washington.* Vol. xi, pp. 109–112.

'98 CALMAN, W. T. On a Collection of Crustacea from Puget Sound. *Ann. New York Acad. Sci.* Vol. xi, No. 13, pp. 259–284.

REVIEWS OF RECENT LITERATURE.

ANTHROPOLOGY.

The Races of Man. — A new treatise upon anthropology, by Dr. Joseph Deniker, of the Natural History Museum, Paris, has been published by the Scribners in "The Contemporary Science Series." It is a very compact little volume of six hundred pages, containing many carefully selected illustrations for the elucidation of the text and numerous bibliographic notes. Comparison with somewhat similar compendiums shows how rapidly anthropology has developed since the publication of Oscar Peschel's *Races of Man* and Fr. Muller's *Allgemeine Ethnographie* a quarter of a century ago. Deniker has treated his subject more fully than the philosophic Brinton in *Races and Peoples;* he has given less space to palethnography than has Professor Keane in *Man, Past and Present.*

Dr. Deniker is inclined to adopt the classification of the anthropologic sciences advocated by Professor Brinton. We commend his views concerning ethnology to the attention of those who fear that this growing young science will seek to absorb all cognate fields of research. "This latter science should concern itself with human societies under all their aspects; but as history, political economy, etc., have already taken possession of the study of civilized peoples, there only remain for it the peoples without a history, or those who have not been adequately treated by historians. However, there is a convergence of characters in mankind, and we find even to-day the trace of savagery in the most civilized peoples. Ethnical facts must not, then, be considered separately. We must compare them either among different peoples, or, down the course of the ages, in the same people, without concerning ourselves with the degree of actual civilization attained."

Three chapters are devoted to "Somatic Characters," dealing successively with the "distinctive characters of man and apes," "distinctive morphological characters of human races," "physiological characters," and "psychological and pathological characters." The principal physical criteria of race — head-form, pigmentation, stature, and hair — receive special attention, and a number of new statistical

tables are furnished in the appendixes to the volume. The hair is given particular prominence in the classification of races according to morphological characters. Confidence is expressed in the ability of Europeans to colonize the Tropics, though little evidence is adduced in support of the opinion. For the first time, we believe, in a general work attention is directed to the nervous susceptibility of savages, which some students of primitive culture regard as an important factor in the development of religion.

"Ethnic Characters," including language, the arts, religion, the family, and social life, are treated in four chapters that seem all too brief to the serious student. Indeed, the entire volume reminds the reader of Tony Weller's comment upon brevity in letter writing.

Half the book is devoted to Races and Peoples. Dr. Deniker modifies somewhat his classification of the races of mankind in general, published in 1889, and now divides the species into twenty-nine races, which in turn are separated into seventeen groups, by taking into account other characters than somatic alone. The ancient inhabitants of Europe are passed over with but brief mention; the Aryan question is dismissed as unanswerable and no longer of any consequence in anthropology. His well-known scheme of classification of the present races of Europe into six primary and four secondary races is given in briefer form than in previously published papers of the Anthropological Society of Paris. The few paragraphs upon the archæology of Asia show that the subject is becoming better known and sheds light upon the ancient history of Europe. The complete account of the migrations of Asiatic tribes within historic times cannot yet be written. So also we can only discern in a general way the elements furnished by the eleven races into which the peoples of the continent are divided.

Dr. Deniker accepts quaternary man in North America as established by the discoveries at Trenton, Little Falls, Minnesota, etc. The mounds of North America are ascribed to the Indians. The modern tribes are considered by ethnographic provinces rather than by groups based upon somatic characters or ethnic traits.

The author is certainly correct in his belief "that even professional anthropologists will be able to consult" this work "profitably." While ethnic maps would have added much to the value of the book, and though there are statements of fact and deductions susceptible to criticism, yet it presents a masterly summary of an extensive and intricate subject.

FRANK RUSSELL.

ZOÖLOGY.

The White-Fish of Lake Chapala. — In 1879 the writer secured a single specimen of the famous "Pescado Blanco," a delicious food fish found in Lake Chapala, in Mexico. This was described under the name of *Chirostoma estor*. It is an atherinoid fish (Silversides or Pesce-rey), translucent and delicate in substance and about a foot in length. Last winter Mr. J. O. Snyder and the writer visited this lake and obtained a very large collection of the "Pescado Blanco." On critically examining it we were surprised to find that the material contained six distinct species, similar in color and appearance but differing in technical characters, and not one of them identical with the original *Chirostoma estor*. Two of these six species have been lately described by Dr. G. A. Boulenger from specimens taken by Mr. A. C. Buller, under the names of *Chirostoma lucius* and *Chirostoma sphyræna* (*Ann. Mag. Nat. Hist.*, 1900, pp. 54, 55). These names have priority over those printed but not yet published by Jordan and Snyder.

D. S. J.

Evermann on Species and Subspecies. — In *Science* for March 23, Dr. B. W. Evermann gives a very sane and accurate account of the formation of species and subspecies, using two species of darters in Lake Maxinkuckee as illustrations. He closes with these words: "We sometimes hear the remark that 'systematists often go too far and describe as new species or subspecies forms which differ but slightly from known forms, that they give specific or subspecific value to differences which are due merely to slight differences in environment.' This misses the whole point. What produces species and subspecies except slight differences in environment with greater or less geographical isolation? And when we see these differences why should we refuse to admit their existence or their meaning?"

D. S. J.

Smith on the Fishes of Woods Holl. — In *Science* for December 15, Dr. H. M. Smith adds a number of tropical species to the list of fishes known from Woods Holl, raising the number of species to 240, the largest recorded from any Atlantic locality north of Key West. The species not hitherto recorded from north of Carolina are the following: *Muræna retifera*, *Apogon maculatus*, *Epinephelus adscensionis*, *Garrupa nigrita*, *Mycteroperca bonace*, *Mycteroperca inter-*

stitialis (?), *Eupomaceutrus leucostictus*, *Teuthis hepatus*, *Teuthis cæruleus*, *Teuthis bahianus*, *Lactophrys triqueter*, *Chilomycterus antillarum*, *Scorpæna plumieri*, and *Scorpæna grandicornis*. All of these are evidently species borne northward in the Gulf Stream. D. S. J.

Eigenmann on Blind Vertebrates. — In *Science* for March 30, Dr. Carl H. Eigenmann publishes his address as President of the Indiana Academy of Sciences on "Degeneration of the Eyes of the Cold-Blooded Vertebrates of the North-American Caves." In this he discusses in detail the eye degeneration of the cave salamanders and cave blind-fishes. He concludes that "degeneration has not proceeded in the reverse order of development. Rather the older normal stages of ontogenetic development have been modified into the more recent phyletic stages through which the eye has passed. The adult degenerate eye is not an arrested ontogenetic stage of development but a new adaptation, and there is an attempt in ontogeny to reach the degenerate adult condition in the most direct way possible." D. S. J.

Microbdella biannulata. — Under this name J. Percy Moore[1] describes a remarkable leech of the family Glossiphonidæ, recently discovered by him in the mountain region of North Carolina, attached to the body of the salamander *Desmognathus fusca*. Leeches of the family named have somites ordinarily composed each of three rings about equal in width. In Microbdella, however, a typical somite is biannulate dorsally, uniannulate ventrally. The two rings into which the somite is divided on the dorsal surface are not of equal width, the anterior one being much broader and corresponding evidently with the first and second rings of a typical somite of Glossiphonia. The segmental sense organs of the dorsal surface are situated in the posterior half of the broad anterior ring. The single broad ring of which the somite is composed on the ventral surface is clearly equivalent to all three rings of a somite of Glossiphonia.

Moore's discovery shows the correctness of two general conclusions recently announced by W. E. Castle[2] as a result of studies made chiefly on Glossiphonia:

1. The sensory ring of the leech somite is the *middle*, not the anterior ring of the somite, as has been generally assumed hitherto.

[1] *Proc. Acad. Nat. Sci. Phila.*, April, 1900.
[2] *Proc. Amer. Acad. Arts and Sci.*, February, 1900.

2. A biannulate condition of the leech somite has probably preceded phylogenetically the triannulate condition; still earlier the somite was probably uniannulate, as in the chætopods. The simple uniannulate somite became biannulate by the separation of a narrow posterior ring from the rest of the somite; the triannulate condition was reached by the separation of a narrow ring at the anterior end of the somite, the sensillæ remaining on the middle ring.

These conclusions have been reached quite independently by Moore, who presents incontrovertible evidence in their support. He further expresses the opinion that the shorter somites commonly found at either end of the body of a leech are not, as they are usually regarded, "abbreviated" somites once multiannulate, but rather represent "stages of development arrested or in progress" from the uniannulate to the multiannulate condition.

The number of somites in the body of Microbdella is probably the same as in Glossiphonia (Clepsine) and Herpobdella (Nephelis), though Moore finds some evidence, not to his mind conclusive, of the existence of an additional somite at the anterior end of the body.

Locomotion of Solenomya. — Solenomya and its relatives show three methods of locomotion which have been studied by G. A. Drew.[1] The first is well represented in Yoldia. This clam possesses a spatula-like foot split into two plates at its distal end. The animal drives this foot into the mud, with the distal flaps held together. These are then expanded and serve as an anchor so that the contraction of the longitudinal muscles of the foot draws the animal through the mud to the place where the foot is anchored. There is no reason to suppose that these mollusks creep about on the expanded foot as snails do. The second method of locomotion, that of leaping, is seen in Solenomya, and especially in Yoldia. When the animal rests sidewise on a smooth surface, the foot is protruded and turned under the lower valve. If the foot is then suddenly contracted, the shell may be thrown end for end some inches. The third method of locomotion is that of swimming. This is accomplished by the vigorous ejection of water from the mantle cavity. The mantle lobes are united except at their anterior and posterior ends. By the separation of the valves, through the action of the elastic ligament, the mantle chamber is filled with water. The anterior opening is then closed by the foot, and by a vigorous

[1] Drew, G. A. Locomotion in Solenomya and its Relatives, *Anat. Anz.*, Bd. xvii, pp. 257–266, 1900.

contraction of the mantle musculature the water is expelled through the posterior opening, thus driving the body of the animal forwards. By a succession of such jets the animal may swim some feet before settling. P.

Ear Bones. — The ear bones of vertebrates have undergone a careful comparative examination at the hands of J. S. Kingsley.[1] In urodeles and cœcilians, where no tympanum exists, a stapes, which develops independently of the otic capsule, is the only element present. In the anura the space between the otic capsule and the tympanum is spanned by three elements, the stapes, the pseudoperculum, and the extracolumella, which collectively constitute the so-called columella of this group. It is important to observe that the intermediate piece, the pseudoperculum, is developed from the posterior wall of the tympanic cavity. In lizards the chain of ear bones consists of only two, the stapes and the extracolumella. Of the three ear bones in the pig the malleus is composed of three parts, a manubrium corresponding to the extracolumella of lower forms, a body representing the articulare, and a membrane bone forming at least a part of the *processus gracilis*. The stapes of the pig is homologous with the stapes of lower vertebrates. The incus which unites malleus and stapes cannot correspond to the pseudoperculum of lower vertebrates, because it develops from the anterior instead of the posterior wall of the tympanic cavity. As this position is that occupied by the quadrate, the incus is believed to be homologous with this bone. It will thus be seen that while the distal and proximal ends of the chain of ear bones in mammals and in lower vertebrates are homologous, the intermediate members are not, being the posterior pseudoperculum in amphibia and the anterior incus (quadrate) in mammals. P.

Otocysts of the Heteropods. — Ilyin[2] has experimented upon Carinaria and Pterotrachea with the view of determining the physiological value of the otocysts in these mollusks. The otocysts are apparently stimulated not as auditory organs but as tactile organs. When both organs are removed, the animal is unable to keep itself correctly oriented and swims in circles. The presence or absence

[1] Kingsley, J. S. The Ossicula Auditus, *Tufts College Studies*, No. 6. (Scientific Series.) 1900.

[2] Ilyin, P. Das Gehörbläschen als Gleichgewichtsorgan bei den Pterotracheidæ, *Centralbl. f. Phys.*, Bd. xiii, pp. 691–694, 1900.

of the eyes does not alter this reaction, so that orientation is not accomplished in these forms by the eye, as in many other animals. The loss of one otocyst does not affect the animal's movements, the remaining one being sufficient to keep it normally oriented. P.

Capillaries and Sinusoids. — C. S. Minot[1] draws attention to the fact that in the vertebrates blood vessels are connected not only by capillaries but also by irregular, minute spaces, for which he proposes the name "Sinusoids." The walls of a sinusoid, like those of a capillary, are formed from a single layer of endothelial cells, but the capillary wall has the form of a tubule, while that of the sinusoid follows the irregular surfaces of the tissue spaces in which it lies; capillaries are tubules, but sinusoids are irregular, branching systems of spaces. Sinusoids form the main blood channels in the pronephros, mesonephros, liver, heart, supra-renal capsules, parathyroid glands, carotid glands (probably), and coccygeal glands. P.

Villi of the Mammalian Intestine. — The development of the villi in the intestine of man and of the pig has been investigated by J. M. Berry.[2] The inner surface in young embryos is at first smooth, but afterwards becomes thrown up into longitudinal folds, such as are found permanently in many of the lower vertebrates. These folds increase in size and then break up into rows of villi. After the first villi become fully developed, new ones are added to the intestinal surface, so that fully developed villi and forming villi may be found side by side, the number of the villi thus increasing with increase of age. P.

Notes. — Dr. Kishinouye has described (*Proc. U. S. Nat. Mus.*, Vol. XXII, p. 125) a new species of stalked jellyfish, *Haliclystus stejnegeri.* This genus has thus far been represented by three Atlantic species. The new form comes from the Commander Islands in the Pacific.

The distome genus Clinostomum, founded in 1856 by Leidy, has been brought forward again by Braun (*Zool. Anz.*, Bd. XXII,

[1] Minot, C. S. On a hitherto unrecognized Form of Blood Circulation without Capillaries in the Organs of Vertebrates, *Proc. Boston Soc. Nat. Hist.*, vol. xxix, pp. 185–215, 1900.

[2] Berry, J. M. On the Development of the Villi of the Human Intestine, *Anat. Anz.*, Bd. xvii, pp. 242–249, 1900.

pp. 484–488, 489–493), who finds in it a natural group, clearly and sufficiently characterized by the anterior end and the genital and excretory systems to be distinguished from all other distomes. He gives a résumé of the known species and adds six new. Almost simultaneously with this has appeared an excellent description of an American species by W. G. MacCallum (*Journ. of Morph.*, Vol. XV, pp. 697–710, 1 plate).

The structure and biology of *Oxyuris curvula* have been studied by H. Ehlers (*Arch. f. Naturges.*, 1899; 26 pp., 2 plates). He confirms the previous opinion that the variably long tail of the female is a mark of advancing age and not a specific character, and finds that, contrary to the ordinarily received view, this species is of pathologic importance. Experimentation showed that direct infection is possible, if not general, and that the period of development covers about three months.

Towards the analysis of the old group of distomes Stossich has recently contributed a study on the dismemberment of the genus Brachycœlium Duj. (*Boll. Soc. Adr. Sci. Nat.*, Trieste, Vol. XIX, pp. 7–10), and a second paper on the partition of the genus Echinostomum Duj. (*ib.*, pp. 11–16).

In some biological observations on Galeodes and Buthus, E. Lönnberg (*Ofv. Kgl. Vet.-Akad. Förh.*, 1899, No. 10, pp. 277–284) records that the poison of the latter was not strong enough to kill the former, and that the belief in the self-destruction of the scorpion when surrounded by fire rests on erroneous observation. In Galeodes it is the mechanical power of the jaws only that renders it dangerous, and this is not sufficient to pierce the human skin.

Another paper on the fishes of the Caucasus, based on Dr. Radde's collections, is published in German and Russian by Dr. S. Kamensky, assistant in zoölogy in Charcow. Numerous new species of Barbus (Barbel) are described and figured.

The fourth part of Boulenger's admirable report on the fishes of the Congo is now published. It includes Cleopaidæ, Mormyridæ, etc., and the descriptions are accompanied by excellent plates.

NEWS.

THE German Society of Naturforscher und Artze meets this year at Aachen from the 17th to the 21st of September.

Mr. Dean C. Worcester has resigned his position as assistant professor of zoölogy in Michigan University, to accept his appointment as member of the new Philippine Commission.

Dr. Th. M. Fries, professor of botany in the University of Upsala, has retired.

The British Association for the Advancement of Science meets this year at Bradford, beginning September 5, under the presidency of Sir William Turner.

An International Congress of General Botany is to be held in Paris from the 1st to the 10th of next October. The Congress will be under the auspices of the government in connection with the Exposition.

The Biological Laboratory of the Brooklyn Institute of Arts and Sciences at Cold Spring Harbor, Long Island, announces the eleventh season of summer instruction in natural history.

Professor C. B. Davenport will have for his staff: Professor H. S. Pratt, comparative anatomy; Professor C. P. Sigerfoos, embryology; S. R. Williams, zoölogy; Gertrude C. Davenport and W. L. Tower, microscopic methods; Dr. D. S. Johnson, cryptogamic botany; Dr. H. C. Cowles, phanerogamic botany; W. C. Coker, botany; Professor N. S. Davis, bacteriology; Dr. H. A. Kelly, nature study; W. H. C. Pynchon, photography. The laboratory will be open from July 2 to August 25. Correspondence should be addressed to Professor Franklin Hooper, 502 Fulton Street, Brooklyn, or to Professor C. B. Davenport, University of Chicago.

The Ohio State University announces a course of study for the summer of 1900 at its Lake Laboratory, at Sandusky, Lake Erie. Four courses are offered in zoölogy and three courses in botany. The staff consists of Professor H. Osborn, zoölogy and entomology; Assistant Professor Jas. S. Hine, entomology; F. L. Landacre, zoölogy; Professor W. A. Kellerman, botany; Assistant Professor

J. H. Schaffner, botany. The school will open on July 2 and will continue for eight weeks. Correspondence should be addressed to Professor Herbert Osborn, Ohio State University, Columbus, Ohio.

The Marine Biological Laboratory at Woods Holl announces a special course in nature study designed to meet the needs of teachers. The course will commence on July 5 and extend over a period of six weeks. The courses of instruction in botany will include cryptogamic botany by Dr. Davis and Mr. Moore, plant physiology by Dr. R. H. True, plant cytology and micro-technique by Dr. Davis. Correspondence should be addressed to Professor C. O. Whitman, University of Chicago, or to Professor Ulric Dahlgren, Princeton University.

We are indebted to the May issue of the *Review of Reviews* for the following announcements:

Mr. Albert L. Arey announces the eleventh season of his natural-science camp for boys at Canandaigua, N. Y. Instruction is given in the subjects of biology, entomology, taxidermy, and photography.

The Rhode Island Summer School for Nature Study will hold its second session on July 5–20, at Kingston, R. I. Tuition is free to teachers in the schools of Rhode Island.

Beloit College, Wisconsin, will hold a summer school on Madeline Island, Lake Superior, from July 26 to August 30.

A school of applied agriculture and horticulture will be established near New York City, to open in September for study and practical training. Students will have the use of the laboratories and the extensive collection of plants in the museum, the conservatories, and upon the grounds of the New York Botanical Garden. The work will be under the direction of Mr. George T. Powell.

Appointments: Dr. Antonio Baldacci, docent for botany in the University of Bologna. — Dr. Alexander Balint, docent for zoölogy in the University of Klausenburg. — Dr. C. R. Bardeen, professor of anatomy in the University of California. — Dr. Llewellys Barker, of Johns Hopkins, professor of anatomy and neurology in the University of Chicago. — Dr. A. N. Berlese, professor of botany in the University of Sassari, Sardinia. — Dr. Albrecht Bethe, docent for physiology in the University of Strassburg. — Dr. H. Böckh, professor of mineralogy and paleontology in the Akademie in Schemnitz, Hungary. — Dr. Hermann Braus, professor extraordinary of anatomy in the University of Würzburg. — Dr. O. Brefeld, professor of

botany in the University of Breslau. — Dr. Willy Bruhns, professor extraordinary of mineralogy and petrography in the University of Strassburg. — Dr. O. Burger of Göttingen, professor of zoölogy in the University of Santiago, and director of the zoölogical section of the National Museum. — Dr. W. E. Castle, instructor in zoölogy in Harvard University. — Howard Emlyn Davies, assistant in bacteriology in the University of Chicago. — Dr. Gustav Fritsch, honorary professor of physiology in the University of Berlin. — Dr. Fünfstück, professor of botany in the Stuttgart Polytechnical School. — Mr. A. W. Grabau, instructor in geology in the Rensselaer Polytechnic Institute at Troy, N. Y. — Frederick O. Grover, professor of botany in Oberlin College. — W. F. E. Gurley, associate curator of paleontology in the University of Chicago. — Dr. J. B. Hatcher, of Princeton, curator of vertebrate paleontology in the Carnegie Museum at Pittsburg. — Dr. E. von Hibler, docent for anatomy in the University of Innsbruck. — W. H. Hobbs, professor of mineralogy and petrography in the University of Wisconsin. — Dr. E. O. Jordan, associate professor of bacteriology in the University of Chicago. — Dr. F. R. Kjellmann, professor of botany in the University of Upsala. — Eduard Lampe, conservator of the Natural History Museum at Wiesbaden. — Dr. Frank R. Lillie, of Vassar College, assistant professor of zoölogy in the University of Chicago. — Dr. Jacques Loeb, professor of physiology in the University of Chicago. — Dr. Karl Mez, professor extraordinary of botany in the University of Halle. — Dr. Luigi Montemartini, docent for botany in the University of Pavia. — Dr. A. Osann, professor extraordinary of geology in the University of Basel. — Dr. F. Sandor, docent for mineralogy in the University at Agram, Austria. — Dr. von Schmidt, docent for histology and embryology in the University of Jena. — Dr. Max Semper, docent for paleontology in the technical school at Aachen. — Dr. Angelo Senna, docent for zoölogy and comparative anatomy in the Institute for Superior Studies at Florence. — G. Severin, the entomologist, conservator of the Natural History Museum in Brussels. — Dr. Wilson R. Smith, instructor in botany in McMaster University, Toronto. — Dr. Hans Solereder, professor extraordinary of botany in the University of Munich. — Dr. Stahr, docent for anatomy in the University at Breslau. — Dr. A. Steuer, docent for geology in the Darmstadt Technical School. — Dr. Alexander Tornquist, professor extraordinary of geology and paleontology in the University of Strassburg. — John E. Webb, assistant in physiography and biology in the University of Chicago. — Stuart Weller, instructor in geology

in the University of Chicago. — Dr. Gregg Wilson, tutor in zoölogy in Heriott-Watt College, Edinburgh. — Mr. J. B. Woodworth, of Harvard, assistant on the New York Geological Survey. — H. Woods, tutor in paleozoölogy in the University of Cambridge.

Deaths: Émile Blanchard, zoölogist, at Paris. — Mr. Andrew Bolter, entomologist, in Chicago, March 18, aged 80. — John Brooks Bridgman, student of Hymenoptera, at Norwich, England, October 6, aged 63. — W. E. Brooks, ornithologist, at Mount Forest, Ontario, aged 70. — Giovanni Canestrini, professor of zoölogy and comparative anatomy in the University of Padua, February 14. — Edouard Coucke, student of Coleoptera, in Brussels. — Frank Hamilton Cushing, ethnologist, well known for his studies of the Zuñi Indians, April 10, aged 43. — François Decaux, entomologist, in Neuilly. — George Dowker, botanist and geologist, at Ramsgate, England, September 23, aged 71. — Dr. A. Ernst, formerly director of the National Museum at Caracas, Venezuela. — Richard Fereday, student of lepidoptera, at Christchurch, New Zealand, August 30, aged 79. — Hans Bruno Geinitz, the geologist and paleontologist, at Dresden, January 28, aged 86. — Walter Götze, botanist, in German East Africa. — Baron J. C. L. d'Hamonville, ornithologist, near Manonville, France, November 17, aged 69. — F. L. Harvey, professor of natural history in Maine State College and botanist and entomologist to the Maine Experiment Station, by suicide, March 6, aged 50. — Baron Oskar von Loewis, of Menar, åt Kudling, Livonia, an ornithologist, Aug. 6, 1899, aged 61. — A. F. Marion, professor of zoölogy in the Faculty of Sciences at Marseilles, January 23, aged 53. — P. Matheron, paleontologist, in Marseilles, Dec. 31, 1899, aged 93. — M. Alphonse Milne-Edwards, the eminent French zoölogist, April 21, aged 64. — Professor St. George Mivart, the well-known zoölogist, in London, April 1, aged 73. — Dr. R. Nasse, geologist, in Berlin, December 2, aged 62. — Dr. Wilhelm von Nathusius, well known for his studies of the shell of birds' eggs in Halle, December 25, aged 78. — Dr. Manuel Paulino d'Oliveira, professor of zoölogy at Coimbra, Portugal, August 25. — Dr. Karl Maria Paul, of the Austrian Geological Survey, in Vienna, February 10. — Dr. Lucien Quélet, mycologist, in Herimoncourt, France. — Mr. George P. Sennet, ornithologist, at Youngstown, Ohio, March 18, aged 59. — Dr. Karl Sommer, student of Lepidoptera in Oberlössnitz, Germany, November 18. — Dr. Wilhelm Zenker, astrophysicist, but earlier a student of arthropods, in Berlin, October 21, aged 70. — Dr. Giovanni Zoja, professor of anatomy in Padua.

NOTE ON CESTODE NOMENCLATURE.

In many of the cestodes there occurs at the beginning of the germ duct an organ, chiefly muscular in structure, which engages the germ cells on their release from the germarium and forwards them into the germ duct. From its characteristic movements in the discharge of this function the organ was well named "Schluckapparat" by Pintner, who made the first extended study of its occurrence and structure. Its presence has been generally recognized by investigators on cestode structure since then, and the term used by Pintner has been widely employed even in French and English papers. The evident disadvantages of such terms as are unpronounceable and unintelligible to students unfamiliar with the German and are furthermore incapable of inflection, serve as my excuse for calling attention to a term in use in the laboratory here to designate this structure, namely, *oöcapt.* Formed on the analogy of Leuckart's generally accepted term "oötype" for a neighboring structure in the reproductive apparatus and conveying the appropriate idea suggested by Pintner, the term "oöcapt" has proved in use both convenient and precise. As it is to be used in papers now being published by some of my students, this explanation is also necessary in order to prevent possible confusion or misunderstanding regarding its origin and meaning.

Henry B. Ward.

The University of Nebraska.

PUBLICATIONS RECEIVED.

(Regular exchanges are not included.)

BÜTSCHLI, O. Untersuchungen über Mikrostrukturen des erstarrten Schwefels nebst Bemerkungen über Sublimation, Ueberschmelzung und Uebersättigung des Schwefels und einiger anderer Körper. Leipzig, Engelmann, 1900. 96 pp., 4to, figures and 4 plates. 11 marks. — CORRENS, C. Untersuchungen über die Vermehrung der Laubmoose. xxiv, 472 pp., 8vo, 187 figs. 15 marks. — HABERLANDT, M. Ethnology. Translated from the German by J. H. Loewe. London, The Macmillan Company, 1900. 169 pp., 16mo, 56 figs. 40 cents. — HILLEBRAND, W. F. Praktische Anleitung zur Analyse der Silikagesteine. Nebst einer Einleitung enthaltend einige Prinzipien der Petrographisch-Chemischen Forschung von F. W. Clarke und W. F. Hillebrand. Uebersetzt und für den Gebrauch in Laboratorien herausgegeben von Dr. E. Zschimer. Leipzig, Engelmann, 1899. 86 pp., 8vo. 2 marks. — LANKESTER, E. RAY. A Treatise on Zoölogy. Part III, The Echinodermata. By F. A. Bather, J. W. Gregory, and E. S. Goodrich. London, Adam and Chas. Black, 1900. vi, 344 pp., 8vo, 220 figs. 15/. — NICHOLSON, H. H., and AVERY, S. Laboratory Exercises, with Outlines for the Study of Chemistry. New York, Henry Holt & Co., 1899. x, 134 pp., 8vo, 26 figs. 60 cents. — PLATE, L. Ueber Bedeutung und Tragweite des Darwin'schen Selectionsprincips. Leipzig, Engelmann, 1900. 153 pp., 8vo. 2 marks. — PRANTL. Lehrbuch der Botanik herausgegeben und neu bearbeitet von Dr. Ferdinand Pax. Leipzig, Engelmann, 1900. viii, 455 pp., 8vo, 414 figs. 4.60 marks. — WAGNER, Ad. Studien und Skizzen aus Naturwissenschaft und Philosophie. III. Ueber das Problem der "angeborenen (apriorischen) Vorstellungen." Berlin, Bornträger, 1900. 77 pp., 8vo. — WILLEY, ARTHUR. Zoölogical Results based on Material from New Britain, New Guinea, Loyalty Islands, and elsewhere, etc. Part III contains Gadow, H., Orthogenetic Variation in the Shells of Chelonia; Willey, Arthur, Enteropneusta from the South Pacific, with Notes on the West Indian Species; Shipley, A. E., On a Collection of Echiurids from the Loyalty Islands, etc. Cambridge, University Press, 1899. pp. 207–356. 10 plates. 12/6.

FARRINGTON, O. C. New Mineral Occurrences and Crystal Forms of Calcite from Joplin. *Missouri Field Col. Mus.* Geological Series, Vol. i, No. 7, pp. 221–241, figures and 3 plates. — GANE, H. S. Some Neocene Corals of the United States. *Proc. U.S. Nat. Mus.* Vol. xxii, pp. 179–198, 1 plate. — GREENE, CHAS. W. Contributions to the Physiology of the California Hagfish *Polistotrema struti.* I. The Anatomy and Physiology of the Caudal Heart. *Amer. Journ. of Phys.* Vol. iii, No. 8. — KERR, J. G. The External Features in the Development of *Lepidosiren paradoxa* Fritz. *Phil. Trans.* Vol. cxcii, pp. 299–330, 5 plates. — MILLEPAUGH, C. F. Plantæ Utowanæ. Plants collected in Bermuda, Porto Rico, etc. The Antillean Cruise of the Yacht *Utowana.* Part I, Catalogue of the Species. *Field Col. Mus.* Botanical Series, Vol. ii, No. 1, 110 pp. — MILLER, G. S., Jr. Seven New Rats collected by Dr. W. L. Abbott in Siam. *Proc. Biol. Soc. Wash.* Vol. xiii, pp. 137–150. — OBERHOLSER, H. C. Notes on Some Birds from Santa Barbara Islands, Cal. *Proc. U.S. Nat. Mus.* Vol. xxii, pp. 220–234. — OBERHOLSER, H. C. Catalogue of a Collection of Birds from Madagascar. *Proc. U.S. Nat. Mus.* Vol. xxii, pp. 235–248. — OBERHOLSER, H. C. Notes on Birds collected by Dr. W. L. Abbott in Central Asia. *Proc. U.S. Nat. Mus.* Vol. xxii, pp. 205–228. — VAUGHAN, T. W. A New Fossil Species of Caryophyllia from California, and a New Genus and Species of Turbinolid Coral from Japan. *Proc. U.S. Nat. Mus.* Vol. xxii, pp. 199–203.

(No. 401 was mailed May 31.)